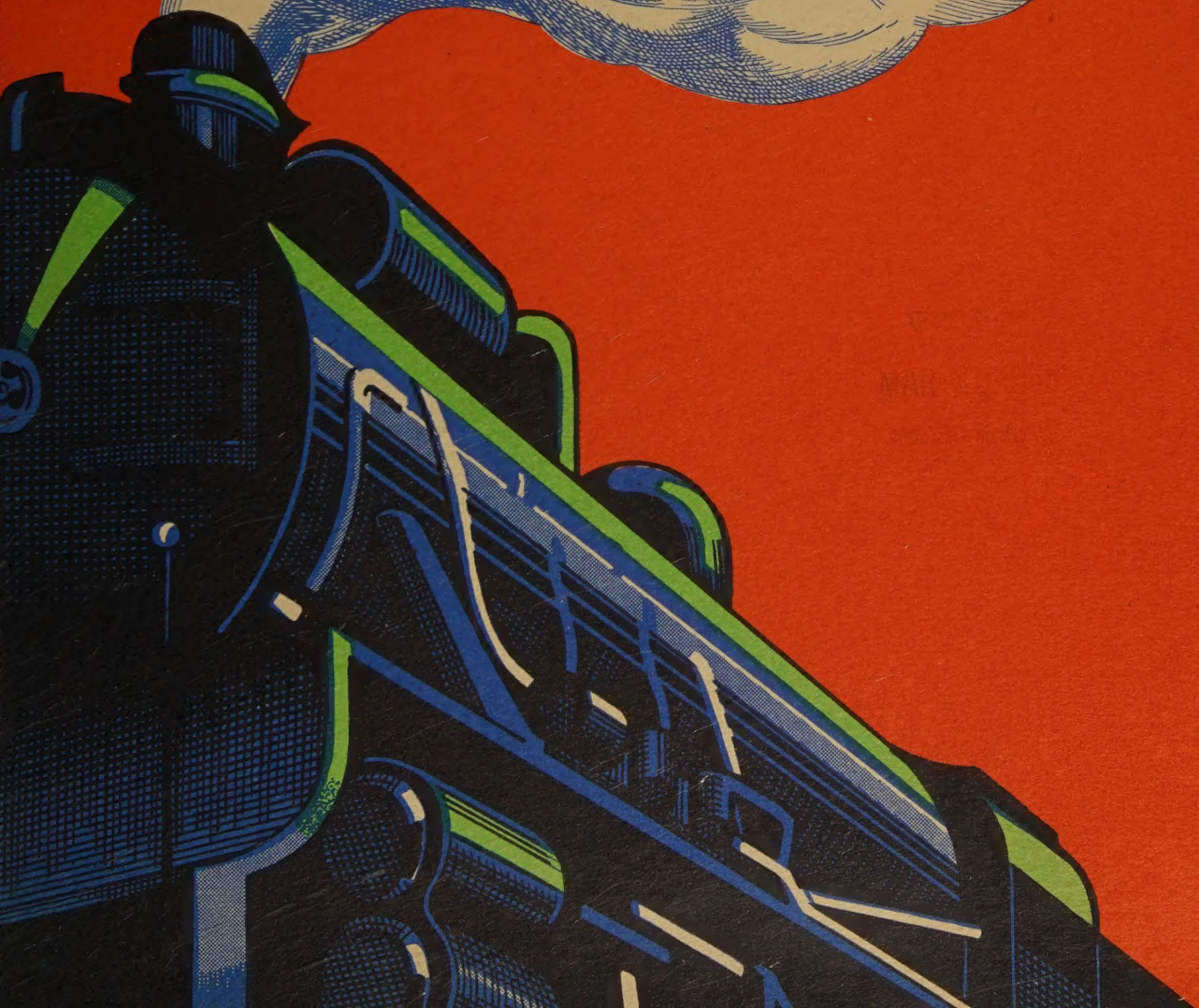
VOL. XXXV. — No. 2. FEBRUARY 1958.

Monthly Bulletin of the International Railway Congress Association

(English Edition)



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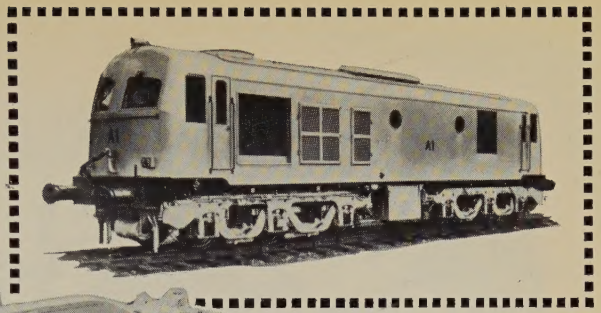

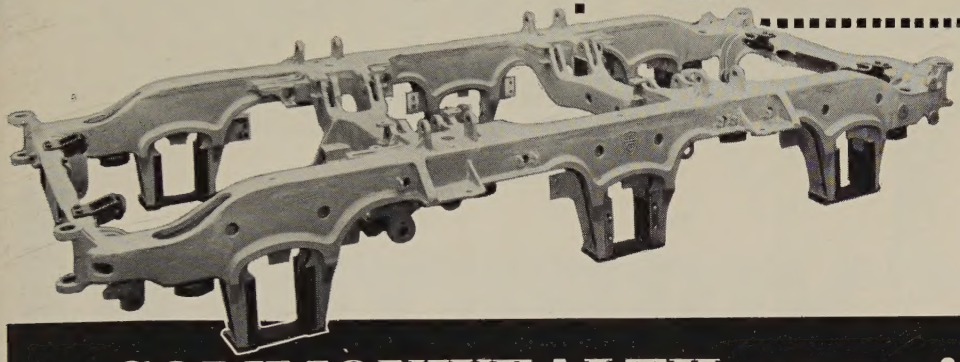

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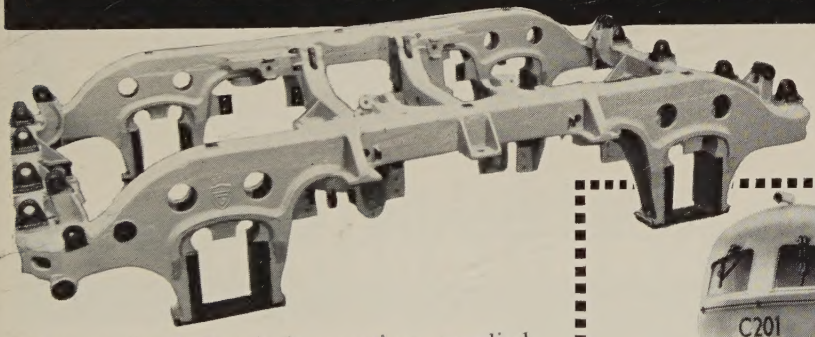

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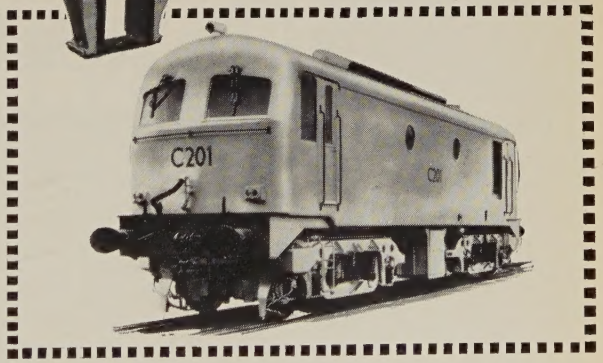

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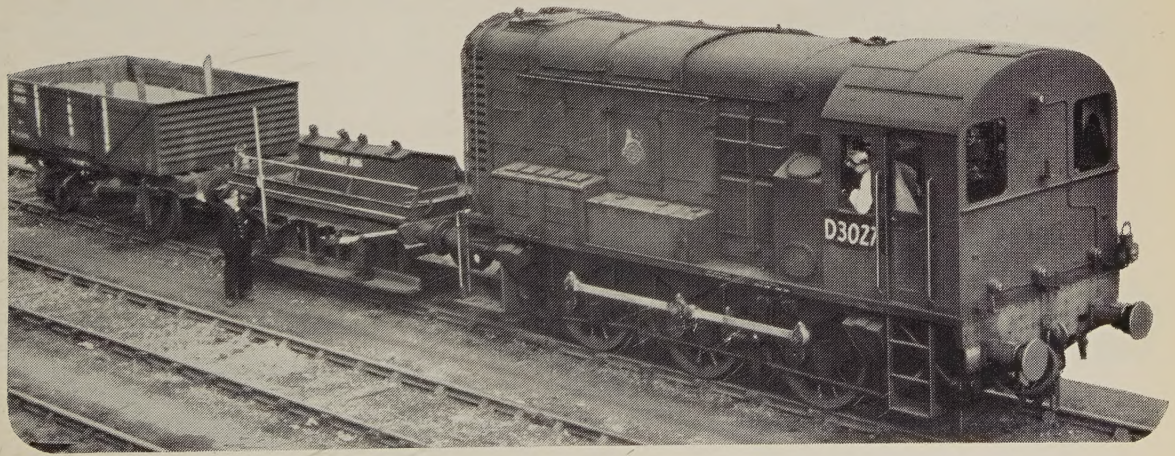

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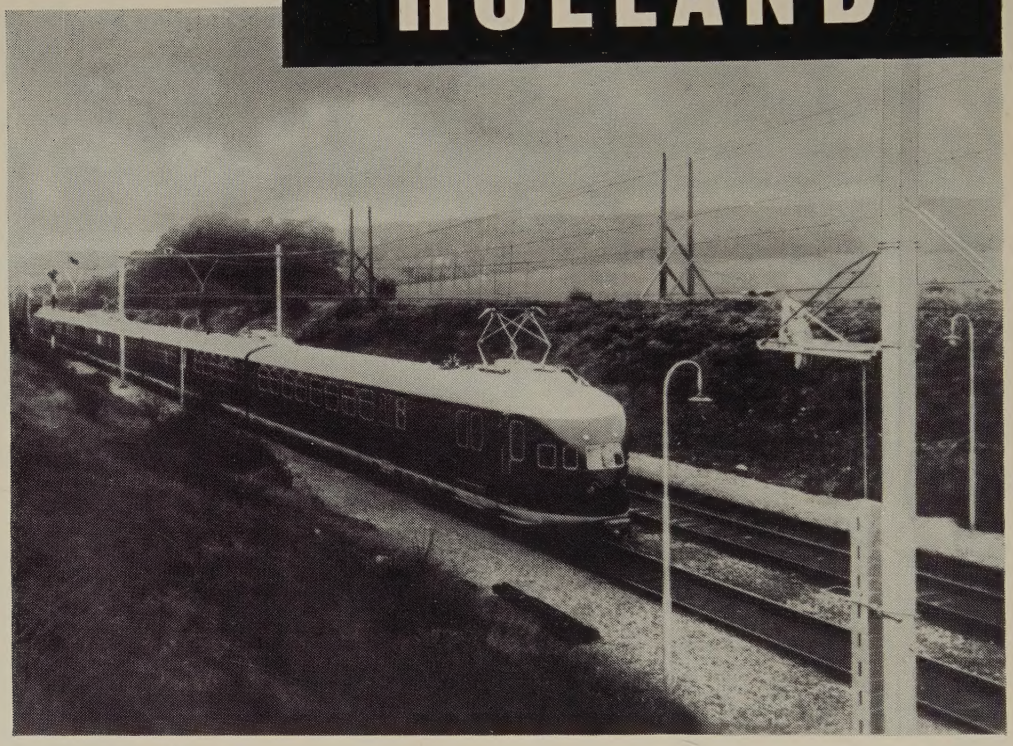

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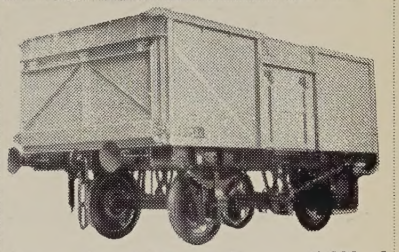

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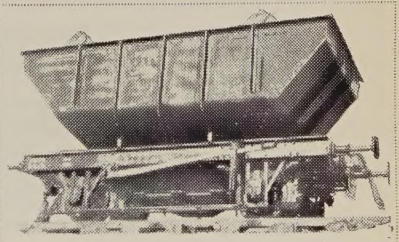
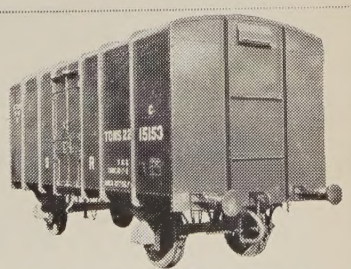


V.J.M. Hopper-type Wagon with drop bottom door for coal, as used by Queensland Government Railways, Australia.



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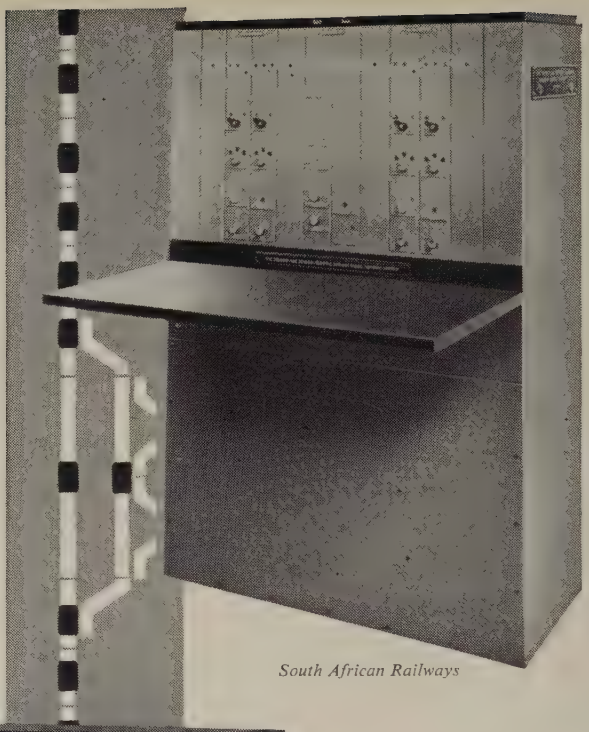
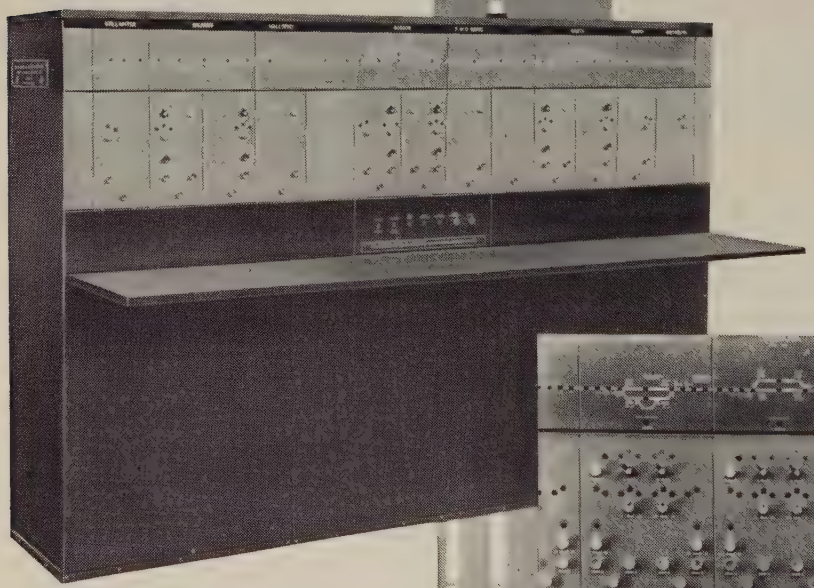
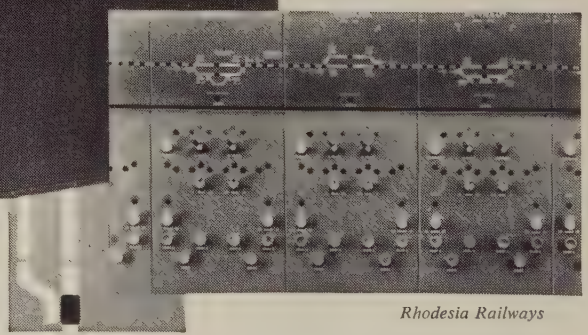


South African Railways



New Zealand Government Railways



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BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[656 .222 .5]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 6.

When changing over to electric and Diesel traction for passenger train services, research of the principles which may lead to a rational and efficient organisation of same.

For this purpose to :

- **work out the social and economic needs and with this object in view, classify the passenger services according to the needs of the populations served, the distances, the volume of passenger traffic and its variations;**
- **fix, for each category, the traffic hours and advisable frequencies as well as the reasonable requirements of the public for comfort and speed;**
- **define the most suitable methods to draw up the timetables (including eventually regular interval train services) : choice of the type of train and rolling stock, fixing the runs.**

REPORT

(Austria, Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Western Germany, Greece, Hungary, Indonesia, Italy, Lebanon, Luxemburg, Netherlands, Poland, Portugal and overseas territories, Rumania, Siam, Spain, Switzerland, Syria, Turkey, Union of Soviet Socialist Republics, Viet-Nam and Yugoslavia),

by R. CARLIER,

Ingénieur à la Direction Générale de la Société Nationale des Chemins de fer belges.

Twenty-six railway Administrations replied to the questionnaire in French relative to question No. 6; we wish here to express our gratitude for the detailed information they have been good enough to supply, information essential for the completion of this report.

CHAPTER I.

General evolution of transport by railway.

The 26 Administrations who replied to the questionnaire have spread their activities over three continents : Asia, Africa

and Europe in particular; they serve a population of some 500 millions of inhabitants distributed over an area of 28 millions of square kilometres (2 1/2 times that of Europe) and operate 270 000 km of lines, of which 73 000 km are of double or multiple track.

a) *Changeover of the traction.*

The changeover of the traction — substitution of electric or Diesel traction for steam traction — constitutes one of the fundamental elements of the evolution of the railways during the last ten years. Com-

121 000 km of lines examined were steam operated: less than 20 years later electric and Diesel traction together were in use on more than 50 % of the same lines.

The evolution is moreover very different from one Administration to another: whereas the African railways are for the most part resolutely looking to the Diesel and have converted the majority of their passenger train service thereto, electrification plays its part, though to a varying extent, in the processes of conversion of the European and Asiatic systems on which, however, extensive areas remain under

TABLE I.

Form of traction		*1938*	*1950*	*1955*
Diesel :	km	13 400	20 700	46 300
	%	11	17	38
Electric :	km	11 700	16 600	19 700
	%	10	14	16

menced well before the second world war the movement of conversion after it became greatly accelerated as is brought out by Table I, the summary of the 15 complete replies covering 121 000 km of lines supplied to answer question 22 *e* (1).

Thus, steam traction, little by little, is being eliminated by one or other of the modern types of traction; for the moment, it is of little importance whether the expansion of Diesel traction is greater than electric traction or if the latter is used especially on heavy traffic lines. What should hold our attention is the amplitude of the general phenomenon of the conversion and the rapidity with which it is being effected: in 1938, steam traction still dominated the field as 80 % of the steam working. Table II gives for the year 1955 a picture of the distribution of electric traction and Diesel traction for the year 1955 as a percentage of the lines operated.

The changeover is far from complete and this is borne out by the many finalised conversion schemes reported in reply to question 12 (1).

It would be an exaggeration to reproduce here the long list of such projects, many of which are in hand: it would appear in all events that their execution will reduce steam traction as a whole to a secondary or insignificant role or even on some systems will eliminate it.

However, this may be, it is significant,

(1) Question 22 *e*: For the years 1938, 1950 and 1955 give for your system the number of kilometres of lines over which the haulage of passenger trains is in majority by Diesel traction, electric traction.

(1) Question 12: If for certain lines of your system a firm decision has been taken as regards changing the form of traction, please indicate these lines (or sections of line) with particulars of the present and future methods of traction.

TABLE II.

Country	Electric traction %	Diesel traction %	Country	Electric traction %	Diesel traction %
French West Africa . .	0	100	*Italy*	38	37
Algeria	6.5	90	*Netherlands*	53	47
Germany (D.B.) . . .	7	27	*Switzerland (C.F.F.)* . .	99	0
Austria	25	11	*Czechoslovakia*	1.5	28
Belgium	8	23	*Tunisia*	0	100
Denmark	2.5	91	*Turkey*	0.3	56
France	16	45	*U.S.S.R.*	9	5

that the necessity for a general changeover is not questioned in any reply and the decision to maintain partially or entirely steam traction has only been inspired on the Administrations, who have done so provisionally for outside reasons such as lack of electric energy or absence of the capital needed for a quick conversion or a total changeover.

b) *Increase in passenger clientele.*

Whilst most railways have resolutely entered the path of the replacement of steam traction, the accelerated increase in travel requirements has resulted, during the last ten years, in a veritable « boom » in transport in all fields : civil aviation favoured by the spectacular progress realised during the war started off afresh in a way that will show itself decisive : the park of automobiles on its side rapidly left behind it the numbers of 1940; the railways finally thought by some to be in decline soon found a larger clientele.

The causes of this evolution are to be found in the growth of activity of all kinds favoured by the maintenance of the high degree of improvement in human conditions which followed it and the general adoption of holidays, circumstances which have made a deep mark on the present epoch.

In railway transport, on the whole of the 20 railway systems of more than 99 % of the 121 000 km of lines covered, the number of passenger kilometres in 1955 amounted to 300 thousand millions. The average increase in passengers relatively to the year 1938 is, therefore, 62 % lying between the limits of 24 % and 230 %. All the railways without exception have been sharing this happy state of affairs.

c) *The concentration of passenger traffic.*

In view of a movement of such magnitude how have the railway Administrations reacted ? This is what Table III shows us. In the first column of this table, we have brought out the character of the movement of the clientele and in the second column that of the traffic in trains/km both relatively to the 1938 figures taken as 100. The third column is the ratio of the indices of the two preceding columns (passengers/km per trains/km) and so brings out the variation again relatively to 1938 of the average frequentation of the trains. Finally, as an indication the fourth column gives for the year 1955 an approximate idea of the density of the passenger train services : the figures therein given are the quotients of the number of trains/km per day by the length of the lines of the railway concerned.

All the railway systems have seen their clientele increase as Table III shows but few of them have multiplied their train services to the same extent so that the

TABLE III.

Country	C	T	F.M.	D
Algeria	152	111	137	5
Germany (D.B.)	151	133	114	36
French West Africa	157	227	76	4
Austria	233	120	194	19
Belgium	128	90	142	38
Denmark	197	121	163	32
Spain	124	114	109	10
Finland	184	127	145	12
France	126	68	185	18
Greece	157	197	80	12

Country	C	T	F.M.	D
Italy	200	125	160	27
Netherlands	221	125	177	61
Portugal	199	119	169	11
Switzerland (C.F.F.)	219	146	150	48
Switzerland (Rhaetian Railw.)	175	124	141	22
Czechoslovakia	250	118	212	22
Tunisia	166	143	116	6
Tunisia (Gafsa Railways)	143	140	102	4
Turkey	330	210	157	6
U.S.S.R.	156	167	94	9
Average	162	121	134	—

C = Index of passengers-km (clientele).
T = Index of trains/km (traffic)
} in 1955 relatively to 1938 = 100.
FM = Index of average frequentation
D = Average density of passenger train timings (1955).

average user of the trains is frankly better. This evolution is entirely normal if at the point of departure considered — in this case the year 1938 — the train service was numerous enough to meet the customers need; consequently, the increase in passengers, to begin with, was absorbed by the existing trains and was reflected by an increase in the percentage of available seats occupied or by an increase in the average weight of the train before causing congestion in the traffic.

As Mr. LORRIOT called to mind in his remarkable report given at the Lucerne Congress of 1947, the kilometric runs of the passenger trains increased all the time between 1926 and 1938 whereas the passengers-km remained stationary or with a downward tendency. The average use had, therefore, fallen off considerably. During the war, however, this situation was reversed for obvious reasons, shortage of rolling stock, shortage of fuel and almost entire suppression of road transport.

We might have believed that as soon as the consequences of the hostilities had disappeared, the Administrations would have gone back to their previous practices and as early as the Lucerne Congress quoted above, the summary 2 to Question III warned the Railway systems by declaring :

« In order to avoid the inflation of train mileages, the latter should be fixed at a level exactly adapted to the necessities of a rational service giving satisfaction to the clientele. »

On reading Table III, it would appear that taken as a whole the railways followed this advice : the figures for the 1945 traffic, the latest to appear before the reports of the Lucerne Congress were affected too much by the special conditions at that time, but those of 1950 and later those of 1955 show well enough that the railways have effected and followed up the revival hoped for : the index of the average user of the 20 railway systems of Table III have increased from 100 in 1938, to 131 in 1950, and to 134 in 1955.

It cannot be denied that this revival has been favoured in a special manner

by the considerable increase in the clientele. This has enabled the railways to increase the average user of the trains whilst developing appreciably their train services. This, however, matters little provided the desired result be attained, namely, the concentration of the passenger transport in high capacity trains, an organisation corresponding closely to railway ideas.

Table III reveals, however, the existence of several particular cases to which we will devote a little time in the hope of discovering the reasons.

These particular cases are the following: two Railway Administrations — those of France and Belgium — showed for 1955 a train-km index less than 100, whereas elsewhere the average train frequentation has fallen since 1938 on three other systems (French West Africa, Greece, U. S. S. R.).

The case of the French system cannot be better characterised than by the following extracts from the previously mentioned report of Mr. LORRIOT (*).

« ... For example (before 1938 — Note of the author), the French National Railways multiplied the passenger services on certain lines and introduced new fast services of limited capacity, while on other lines railcar services at frequent intervals were introduced to meet road competition. A detailed analysis of the financial results of such experiments has proved that the increase in expenditure was considerably greater than the additional receipts earned...

» These following measures, in our opinion, might be found to remedy the situation (deficit of the passenger services — Note of the author):

» .....

» 2) a severe limitation of the regular passenger train services... »

The measure proposed would appear to have been followed by France with particular care, since the number of trains-km on the S. N. C. F. is no longer in 1955 than at the index 68, and the percentage of seat occupation in the S. N. C. F. is higher, at 90 % in 2nd class, than that on any other railway system.

As for Belgium, the trains/km index of 90 in 1955, tends at the present time to reach the level 100 as a result of the electrification of 17 % of the lines of the system: the 1938 train service, particularly congested as it provided its users with at least a train per hour on each of its main lines had shown itself to be a heavy burden and did not survive the war. Thanks to the reduction in the costs of traction resulting from the change of motive power, and the increase in the clientele which showed itself in Belgium as elsewhere, a service as intensive as that of 1938 is now being little by little restored.

In Belgium and no doubt in France, the index of the trains/km is affected moreover in the downwards direction by the substitution of road for rail on many secondary lines.

It is less easy to abstract the reasons for the reduction in the average user of the trains belonging to the three systems of French West Africa, Greece and U.S.S.R.

The size of the latter country — 22 millions of km² against 6 millions for all the other countries considered and the low resulting density of population in spite of its 200 million inhabitants make it difficult to compare its operating conditions with those of the other Administrations; it would appear, however, that the fall in average user — it is moreover only 6 % — is due to the anxiety of the Administration of the Sovietic Railways to ensure in spite of everything to the very dispersed population a consistant train service so that every one would benefit from the favoured improvement in the most populated regions by the increase in users: it is to be noted in regard to this that the Sovietic Railways declare in their report:

« On the local lines, it is possible for the passengers to make short distance journeys (less than 300 km) each hour of the day. »

(*) See « Congress Bulletin » for January 1947, p. 32/16.

In Greece, the Hellenic Railways, since the war, have operated by railcars which made it possible to multiply the services and speed up the time tables. The object of this improvement is to meet the demand of the users, by making provisions as far as is possible to abandon the railway in favour of motor buses and aircraft. Here no doubt is to be found the reason for the fall in the average use of the trains.

d) *Evolution of comfort.*

The endeavour to provide the greatest comfort for the traveller has always been one of the major preoccupations of the Railway Administrations, but never before have improvements of such diversity been brought out in such numbers as during recent years.

New techniques have been perfected, research has penetrated fields scarcely explored before and what is quite remarkable the inferior class, relatively speaking, has benefited most from the improvements. An index particularly revealing of this tendency due largely to the ever growing menace of automobile competition and the democratisation of transport is the reduction of the number of classes of vehicles to two, carried out on many railways during 1956.

We will not linger here in the region of the improvements made in the running gear, insulation, heating, lighting and sound deadening the stock : these technicalities are applied generally to all stock to be built without distinction of class. Many Administrations moreover are themselves modernising their existing stock.

One of the problems which on the other hand should hold our attention is the increase in the space allocated to each traveller, particularly in the lower class; an improvement admittedly essential, is generally realised in all new building. The way of doing it, however, differs widely from one Administration to another.

However it may be, this betterment will sooner or later affect the frequency of the train service.

Actually, we have seen above that on most railway systems the average occupation has been growing since 1938 and that the increase in the user of the railways has not been followed by a proportional development in the train services.

As the passenger is given greater space per seat, the result all things being equal is to lengthen the train. The limiting length of the trains caused by the capacity of the permanent way usually by nature hardly extendable will be reached with a smaller number of travellers than formerly. The result will be a quicker reinforcement of the train services if the number of passengers continues to grow.

Although the extra comfort so provided for the passenger should have generally pleasant consequences we think, however, the Administrations cannot neglect this particular aspect of the problem and that they have an interest in keeping within limits this evolution now going on.

The betterment of comfort moreover is not limited to increasing the space per passenger : the seats in the lower class are now provided in most cases with upholstery; the best form of seat has been the subject of research and development on some systems. Carriages with adjustable seats are in service on some lines.

On night journeys, the coaches with bunks (couchettes) are being built by the Railway systems in ever increasing numbers. They have been received with increasing success and a rapid increase in the number of sleeping berths can be expected in the next few years.

Other improvements in comfort have been introduced though on a more restricted scale; usually, these have been reserved to named or Flag trains and to some particular ones amongst these. As an example of such betterment, air conditioning may be quoted.

The replies of the Administrations to question 16 (1) are more or less in agree-

(1) Question 16 : Having regard to the length of journey, what degree of comfort is it desirable to provide for the passengers ?

ment when the operating conditions sometimes widely different are taken into account.

For short runs, such as those taking one hour, the rolling stock is of the ordinary type; the coaches as a rule are all metal and are carried on 4 pairs of wheels, either railcars or rail motor coaches, the centre corridor is accepted and the upholstered seats in the lower class are recommended. Only a few railways provide for the sale of refreshments from a trolley passing through the coaches on such distances.

When the journey time exceeds 3 hours, the majority opinion is that the passenger should have side corridor vehicles or large compartments or sections with adjustable seats. The train too should include a snack-bar or its equivalent, and a dining car at least at meal times. Certain railways in addition provide washing facilities with separate toilets and the servicing thereof by travelling personnel, radio equipment, and in hot countries, air conditioning.

In journeys of 1 to 3 hours, the boundary between the two conceptions is not very clearly settled; some Administrations assimilate such journeys with those of short duration, others on the contrary consider the trains should be equipped in the same way as those with journeys of over 3 hours : service of refreshments along the train or snack bar is recommended.

For night journeys, sleeping bunks or sleeping cars are recognised by all as necessary, starting with journeys of 5 to 6 hours on some systems or 7 to 8 on others. Some Administrations consider it even desirable on night trains to provide for their users only places on which they can lie down.

e) *The evolution of speed.*

The operating conditions, the distances and the gradient sections of the lines differ too widely between one Administration and another for any useful comparison to be made between the average speeds of their express trains. We will therefore just examine the changes in speeds since 1938.

Generally speaking, the changes are slight. The second war resulted almost everywhere in a reduction of the overall speed of the express trains, this being still felt in 1950 on some of the most seriously affected Administrations. By 1955 however, this influence had disappeared generally.

Amongst the 15 systems who supplied full information :

— 3 only show figures below those of 1938, the reduction in speed being of the order of 5 km/h;

— 9 have returned to figures slightly exceeding those of prewar;

— 3 attained, in 1955, definitely higher speeds. The most marked acceleration of 25 to 80 % is noted on two systems, which in the period considered carried out the complete dieselisation of their passenger trains. As regard France, the third of the Railways concerned, accelerations of 15 to 20 km/h of the through trains over the main lines have been made; speeds of the order of 110 to 125 km/h being run on certain lines and with the fastest trains.

f) *Average length of passenger journeys.*

Included in the many statistical data contained in the replies is the figure of the average distance in km travelled by the passengers. This figure is particularly revealing as to the normal requirements of passengers remaining faithful to railway travel. We cannot but be struck by the relatively small difference between the figures supplied by totally different railway systems. In the Great Duchy of Luxemburg, the average passenger journey is 21 km, it only rises to 86 km on the U.S.S.R. system though the ratio of the areas of the two countries is as 1 to 1 000 !

The figures given by the other Administrations are of the same order of magnitude: 28 km Germany (D. B.), 30 km Switzerland, 33 km Belgium, 40 km Netherlands, 58 km France, and Spain 69 km.

An adjustment however has to be made

to these figures in order to take into account suburban traffic. As this involves a considerable number of passengers travelling short distances it has considerable influence on the average figure. France and the U.S.S.R. in their replies have supplied separate figures for short distance traffic (suburban) and for the remainder of the traffic these being respectively :

— 14 km and 110 km (average 58 km) France;

— 23 km and 438 km (average 86 km) U.S.S.R.

We may suppose not unreasonably that on the other railway systems, « mutatis mutandis » the division to be sensibly the same. On this hypothesis, the average journey length, of the order of 50 km, would result from the mass movements over short distances, i.e. of 10 to 25 km and average distance journeys of 50 to 200 km on other systems than the U.S.S.R.

CHAPTER II.

The pattern of the timetables on the main lines.

a) *Journeys of over 2 000 km.*

The limited size of most of the countries covered by the French Questionnaire prevented sufficient data relating to journeys over 2 000 km being collected for any comparison to be made. Even in international traffic, there are very few trains in Europe running over 1 000 km and those of 2 000 km and over are almost exclusively the preserve of the U.S.S.R.

The Ministry of Communications, of the U.S.S.R. has selected as the typical line of his method of operating very long distance trains, the line from Moscow to Tbilissi. This artery is 2 500 km long and serves in particular the cities of Orel, Kharkov and Rostov.

Every day on this line an average of 6 000 passengers leave Moscow : the number reaches 9 500 in Summer. In view of the average length of the individual journey of long distance passengers (438 km) obviously only a few of the passengers leaving Moscow travel the whole way and the passengers change continuously during the journey. Nonetheless, the U.S.S.R. railways take steps to ensure that their users can be carried directly through to the most distant centres.

The timetables are arranged to cover a common trunk line from which important lines branch off. Over the trunk line, in Summer, 28 trains are worked in each direction over the first section of 382 km to Orel; 27 trains continue to Koursk 536 km and 26 to Kharkov 779 km; 804 km from Moscow, there is the important branch line to Eupatoria, Simferopol, Sebastopol 1 539 km over which 8 trains operate, etc. Finally, two trains make the whole journey from Moscow to Tbilissi.

A remarkable feature is that at 1 650 km from Moscow, 16 of the 28 trains are still working over the common trunk line.

The line is electrified at each end for a distance of several hundred kilometres. Schemes for changing the form of traction affect the line from end to end, with electric traction predominating (1 400 km).

The departure times from Moscow are spread over between 9 h 30 to 2 h 50, preferably during the evening and early night, as is shown by there being 18 trains leaving between 17 h and 2 h 50, and of these, 10 between 19 and 24 h. The Soviet report refers to this subject in the following terms :

« As regards the choice of the times of departure of long distance trains, this is selected in such a way as to obviate the loss of a working day as a consequence of making the journey. This is the reason why the departure times are arranged at the end of the evening between 19 and 24 h, whereas the arrival times occur between 6 and 19 h. This principle is not adopted as fully in the case of trains to pleasure resorts. »

All the trains are made up of coaches which are hauled by locomotives and include sleeping cars, systematically placed

at the disposal of passengers travelling more than 5 to 6 hours by night; in addition, 9 of the trains include a restaurant car.

The overall speed is of the order of 40 to 50 km/h including stops on the journey (nearly 50 between Moscow and Tbilissi). These stops are about 100 km apart on the average on the first part of the journey, and are more frequent as Tbilissi is approached.

To sum up the organisation depends upon the length of the line, it deals with the service of a whole region, the area of which exceeds that of most European countries rather than with a journey from town to town. The predominate desire is to avoid passengers travelling from end to end of the line having to change train.

b) *Traffic over very long distances (1 000 to 2 000 km).*

Although still only to a limited extent, such journeys are worked on some railways on home services but are more general in international services. Table IV gives the main operating characteristics of six services described in the replies to the questionnaire (Question 13).

As can be seen the Paris-Nice line shows many quite distinctive operating characteristics and for greater clearness will be dealt with separately.

As regards the other 5 services, four give connections between large centres of population of 500 000 to 2 000 000 inhabitants. The through traffic from end to end however is not consistent, so much so, that at most only one through train a day can be justified.

Consequently, the many stops en route are mainly due to the need to feed the train in a reasonable manner over its whole run. It appears therefore that in most cases of very long distance travel, other than in Summer, the retention of through trains or coaches is justified by the desire to avoid the minority who do travel from end to end, having to change carriages, always a nuisance.

TABLE IV.

No.	Service	Length km	Traction		Passengers in each direction	Number of trains	Departure times		Number of stops	Minimum time of journey h	Overall speed km/h
			electric km	Diesel km			outward	inward			
2	Brussels-Belgrade	1 854	582	—	200 (1)	1	22.49	22.35	25	32	60
3	Milan-Palermo	1 547	1 547	—	100 (2)	1	14.45	10.50	11	24	66
4	Dakar-Bamako	1 230	—	1 230	—	1 (4)	19.15	12.00	17	26	45
5	Brussels-Copenhagen	1 220	100	—	75 (1)	1	22.49	9.30	15	20	60
6	Brussels-Vienna	1 199	601	—	225 (1)	1	18.27	16.30	14	19	63
7	Paris-Nice	1 088	512	—	6 000 (3)	5	9.15	8.00	9 to 21	11	76 to 100
							13.10	12.00			
							20.00	16.10			
							20.10	19.20			
							21.25	19.45			

(1) International passengers over the Belgian Railways.
(2) Through passengers.
(3) Passengers on the lowest loaded section of the line.
(4) Three times weekly.

The departure times have been selected in accordance with the following considerations :

— *Lines 2, 5 and 6 :* obligation to connect at Ostend, the effective place of departure of the trains considered, with the boats bringing passengers from England. For the Brussels-Belgrade journey, preference has been given to the timetable dividing the 32 hours journey time into 2 nights and 1 day with the journey by day through the regions most attractive to tourists.

— *Line 3 :* desirability of calling at the large cities located along the journey at convenient times.

The overall speed of the four European trains is comparable one with the other and is of the order of 60 km/h. It is affected by length of the stops at the frontiers (lines 2, 5 and 6) and by train operations during the journey.

The make-up of the train is the classical one : carriages usually of metal construction, dining cars, buffet (lines 3 and 4), sleeping cars, carriage with berths (lines 2 and 6). On the Dakar-Bamako line, on which there are three classes of stock, the first and second are provided with adjustable seats.

To summarise, many intermediate stops, majority of train departures in the evening, attention given to running through trains for long distance passengers, are the common characteristics of the organisation of very long distance traffic. We have already pointed these out in regard to, amongst others, the transport on the U.S.S.R. lines.

Paris-Nice is seen to be differently. As regards its users, the times of the journey, the organisation of the service belong to 400 to 1 000 km journeys, which will be considered later.

The percentage of passengers making the whole Paris-Côte d'Azur journey has not been supplied, but we know the line so well as to be able to state positively that it is quite high for such a distance. Travellers for intermediate towns have other trains available and because of this the number of stops made by the long distance trains can be reduced. It is only during the last part of the journey that, in order to serve the different seaside resorts of the Côte d'Azur, the stops are rather closer together.

The basis of the Paris-Nice service is one day train and one night train per twenty four hours. The night train is duplicated by a sleeping car train. The service also includes another night train serving the less important stations on the line. The service is completed especially by the afternoon ultra fast train de luxe « Mistral », which makes the journey at the overall average speed of 100 km/h. The traveller by this train consequently can spend the morning in Paris or can devote it to reaching Paris.

The « Mistral », a flag train is composed of first class carriages with air conditioning, Pullman coaches, dining cars and bar cars.

The Paris-Lyons line has been electrified during the last few years and the electrification is in hand toward Marseilles.

c) *Long distance trains (400 to 1 000 km).*

Journeys of this kind fit in much better with the size of the railways concerned and are much more widely distributed. From the replies to the questionnaire, we have been able to bring together the description of 19 trains shown on Table V, in which these are grouped according to the number of through trains each day running from end to end of the journey.

Table V brings out the diversity of the types of train services in use for journey of 400 to 1 000 km and shows the need to carry the analysis of the data further if we are to attempt to determine therefrom the principles followed by the Administrations as regards the timetables of passenger trains.

When studying Table V, we cannot fail to note the absence of any relation between the length of the line and the density of the train service, even when in

certain cases the cities at the two ends of the run have more or less the same population. Unfortunately, we have been prevented from making a through examination of this aspect of the problem by the lack of uniformity in the data supplied concerning the users of the lines. Consequently, we have not been able to make comparisons and in particular, relatively to the occupation of the trains on the lines concerned, the influence of the intermediate stations on the route, and the polarising character of the traffic of certain privileged cities.

However, this apparent disorder — absence of relationship between the length of line and density of service — largely fades away if in place of the criterium distance we use that of time of journey, that is to say, distance corrected by speed. We then see some parallelism, rather rough and ready, but tangible between the density of the service and the reduction in the journey time.

On making this observation, we are tempted to conclude that the speed is a paying proposition on lines of 400 to 1 000 km. We will avoid doing so however, because the number of cases examined is too few in view of the diversity of the factors to be taken into account. Nonetheless, we consider that a much more thorough investigation of this hypothesis based on detailed data would be found to be rich in information.

Leaving these considerations aside, the information supplied by the Administrations on the 19 lines enumerated in Table V supply quite enough material for fruitful comparisons and in particular on the choice of the *train departure times.*

In this field, there is no longer any doubt but that the duration of the journey with the number of trains run daily is a deciding factor and that the distance travelled by the train is only of a relatively degree of importance in view of the range of speeds considered controlling the duration of the journey.

For journeys of twelve hours and over, we find again the preference as stated earlier in the case of the longest lines for departures at the end of the evening. In the present case, the night train is still more interesting as the passenger by it loses the minimum of time making as he does the most if not the whole journey outside normal working hours.

In proportion as the duration of the journey lessens, the departure time of the train is made later. The speed of the train may even be lowered so as to ensure the passenger has a night of complete rest even in journeys normally taking 5 to 6 hours.

When the number of passengers justifies a second train this is usually a day train, the speed of which frequently higher than that of the night train is regulated so as to keep the duration of the journey within reasonable limits without breaking either at the beginning or end of the journey into normal hours of sleep.

The departure time of the third train is usually at the beginning of the afternoon, occasionally at the end of the morning for the longest runs so as to arrive at destination at the end of the evening at the latest.

After the service of four trains a day, we see the Flag train, a high speed train (departure times underlined in the Table). We have met it already on the Paris-Nice line and we would recall to mind on this occasion that the operation of this line is that of one of less than 1 000 km to which moreover it is related by its relatively reduced journey time.

The Flag train as it were is universally operated on lines of 400 to 1 000 km, the users of which justify running of four trains a day. There are certain lines on which there are two or even three Flag trains a day.

The time selected for the departure of the Flag trains usually meets one of the following needs :

— to give the passengers a timetable such as will enable them to have the morning free at the starting point and to reach the other end of the run as early as possible in the evening without breaking into the hours of sleep and with the possibility

TABLE V.

No.	Service	Length km	Traction		Passengers per direction	Number of direct trains	Departure time		Number of stops	Minimum time of journey h	Overall speed km/h
			electric km	Diesel km			Direction indicated	Reverse direction			
8	*Brussels-Milan* . . .	968	968	—	150 (1)	1	18	22	20	14	65
9	*Brussels-Munich* . . .	857	453	—	375	2	8, 23	9, 19	15	12	60-70
10	*Saïgon-Nhatrong* . . .	415	—	—	500	2	6, 20	8, 19	?	12	36
11	*Helsinki-Oula*	753	—	—	500 (2)	2	18, 19	16, 19	10 to 22	15	50
12	*Alger-Oran*	422	—	422	?	3	7, 13, 22	7, 14, 22	10 to 26	5	47-81
13	*Madrid-Barcelona* . .	688	156	×	1 600	4	9, **14**, 21, 22	8, **13**, 19, 21	6 to 37	10	49-68
14	*Madrid-Hendaye* . . .	640	166	×	1 400	4	10, **13**, 22, 23	**9**, 9, 19, 22	9 to 15	9	50-73
15	*Brussels-Basle*	596	596	×	275 (1)	4	8, **14**, 18, 23	5, **13**, 14, 24	7 to 11	6	75-98
16	*Athens-Thessaloniki* .	520	—	×	?	4	7, 11, 18, 20	9, 13, 21, 24	17 to 29	11	43-52
17	*Hamburg-Basle* . . .	983	124	×	4 500 (3)	6	7, **13**, 14, **20**, 22, 23	7, **9**, 15, 18, **22**, 1	8 to 24	10	61-105
18	*Paris-Bordeaux* . . .	581	581	—	5 000	6	8, **14**, 18, 21, 23, 23	8, **12**, 12, 18, 22, 2	0 to 10	5	70-116
19	*Istambul-Ankara* . . .	578	—	×	?	6	9, **10**, 15, 18, 20, 21	**8**, 9, 17, 19, 21, 23	6 to 36	9	41-61
20	*Vienna-Innsbrück* . .	568	568	×	?	6	6, **9**, 9, 14, 21, 24	6, 9, **12**, 14, 21, 23	4 to 39	8	53-70
21	*Praha-Bratislava* . . .	396	—	×	?	6	6, 9, 14, **18**, 19, 24	**4**, 4, 9, 15, 22, 23	2 to 12	5	55-78
22	*Turin-Venice*	420	267	—	300 (4)	8-6	6, 9, 11, 14, **16**, 17 20, 21	**7**, 10, 11, 14, 17, 1	7 to 19	5	57-79
23	*Cologne-Basle*	530	124	×	1 700	8	**7**, 8, 10, 10, 12, 14 23, 23	7, 9, 11, 13, 14, **17**, 22, 23	8 to 18	6	72-91
24	*Cologne-Munich, through Stuttgart* .	627	353	×	2 600	8-9	**7**, 8, 8, 12, 23, 23, 23, 3	6, 9, 10, 12, **16**, 19, 20, 22, 22	7 to 16	8	63-84
25	*Cologne-Hamburg* . .	458	—	—	3 600	11	5, **7**, 8, 11, 13, **15**, 16, **17**, 17, 23, 23	6, **7**, 8, **10**, 11, 15, **17**, 17, 19, 23, 24	7 to 15	6	60-82
26	*Rome-Milan*	632	632	—	2 500 (1)	13	7, 9, **11**, 11, **14**, 15, **18**, 21, 23, 24, 1, 3	6, 7, **9**, 10, **13**, 13, 14, 15, 16, **18**, 21, 23, 23, 1	2 to 25	6	70-104

× Partly operated by railcars.
(1) International passengers leaving Belgium.
(2) Passengers on the busiest section.
(3) Passengers on the whole line including all trains.
(4) Through passengers.

of continuing the journey immediately by night train;

— for journeys sufficiently short as a result of the acceleration of the Flag train timetable to make a double journey out and back in the day, with a sufficient gap in the times at the destination station for the passenger to do his business;

— for other journeys the time of which has been reduced to that of an evening, provide a train leaving after the working hours whilst at the same time enabling the passenger to avoid a night in the train.

The flag train is also spread over international service on the main lines: since 1957, this is represented by the T.E.E. services which have put flag trains into international day time working on many European systems.

In Germany (D.B.), on the Hamburg-Basle service, there is also a fast night train, a rail motor train with lying down accommodation.

When the number of trains leaving daily exceed five, the service evidently acquires a more marked character of permanency but the morning and evening hours and to a less degree between 13 and 15 hours remain reserved. The permanence of the service is moreover cut by two intervals as departures and arrivals ought as far as possible to be suspended between midnight and 6 o'clock.

To summarise for journeys of 400 to 1 000 km, the passenger always has at his disposal a night train, almost always a day train, and very frequently an afternoon or evening express train. In proportion as the time of the journey is shortened, half day trains are made available for his use, the morning departure time is so arranged that whenever possible the passenger will arrive at destination before 14 hours. The afternoon or evening departure time is intended to end before 24 hours and that of the night should be within the hours of midnight and 6.0 a.m.

There are naturally exceptions to these rules but they are few and affect mainly trains with which the journeys considered are only part of the whole distance. On the lines of 400 to 1 000 km, the number of stops remain rather high; the flag trains are exceptions to this rule and runs over 200 to 300 km without intermediate stops are not rare in this category.

The relative frequency of stops of ordinary trains should be considered as a consequence of the reduced average distance travelled by passengers, which is shown to be much below the distance covered by the trains concerned. As for the very long distance trains, the stops are justified by the need to feed the trains from end to end of the journey by calling on travellers from intermediate points to ensure the trains being adequately filled.

On certain lines with heavy user, and on very short lines, the end to end travellers require a certain stability and the railway system can therefore use two policies: one to run a limited number of trains with few stops and complete the service by limited runs of semi-direct trains, the other to multiply the number of long distance trains but allowing more numerous stops.

The first solution will be received favourably by the end to end passengers provided the service offered them is sufficiently frequent. This solution consequently is only possible on lines with heavy traffic and passengers from intermediate stations have to put up with certain sacrifices such as longer journey times and often a change of train on the journey with also a lower frequency of train. This practice is hardly to be recommended if the travellers over part of the journey are the more numerous, the most frequent case over the distances considered.

The second solution satisfies the travellers for the intermediate cities but lengthens the duration of the overall journey and will displease the through end to end passengers. This solution however is the one most often adopted with a compromise: the Flag trains being reserved to the long distance passengers.

Consequently between 400 and 1 000 km, the service generally is based on a varying number of trains with many stops 25 to

50 km apart. To these are added one or more Flag trains which have to give long distance travellers, when numerous enough, accelerated timings with few or even no stops (cf. Paris-Bordeaux).

The overall speed of the trains corresponds to the double aspect of the organisation; 50 to 75 km/h for stopping trains, 90 to 100 km/h and sometimes higher for the flag trains.

As regards the *rolling stock* used, it conforms with what we said in Chapter 1 relatively to the night trains and day trains of more than 3 hours journey, namely all metal coaches with side corridors, restaurant cars, buffet cars, sleeping cars, coaches with bunks (German, Austrian, French, Turkish coaches). Certain trains are all sleeping car trains but these are then a duplicate of a train with lying down accommodation or with ordinary seats.

The railcars are fairly widely distributed and sometimes have a restaurant fitted.

The rolling stock of the flag trains is ultra-modern and air conditioning more and more widely distributed. Most of these trains are well known and have been described many times in the specialist press. We will not again describe them here but will be content to mention amongst the most notable the rail motor T.E.E. trains of Germany, France, Italy, Netherlands and Switzerland. The T.A.F. railcars and T.A.L.G.O. trains of Spain, the Electrotrains of Italy, the German railcars with lying down accommodation and the various types of especially well turned out vehicle of many railway systems.

d) *Average mileage traffic (100 to 400 km).*

The data collected of traffic operation over 100 to 400 km, summarised in Table VI reveal a new evolution in operating conditions when the journey time is reduced to 4 hours or less.

Excluding the two African lines (27 and 28), the services dealt with in Table VI profit from a fairly great number of passengers, are run over by more and more numerous trains and are either electrified throughout or will be soon.

The distribution of the departure times is modified to some extent: the marked preference for night trains leaving late in the evening, characteristic of the long distance lines completely disappears. Should there still be night trains on lines of 100 to 400 km length, most of these are either trains from or for much further departure stations or destinations which only cover the travellers of the line itself to a limited degree or post office trains to which carriages are added but which would not be operated in passenger service only. The few night trains running distances of 250 to 400 km, however, have to run at lower speed if the passengers lying down are to have sufficient rest and also to be at their destination at a reasonable hour of the morning. Experience tends to provide that if the passengers have a fast service at the end of the day they definitely prefer it to such slow night trains. The daytime departures on their side are less in groups than before. On the lines over 400 km long, these departures usually were arranged in groups, one in the morning, one in the middle of the day and one in the evening. In the case of the lines dealt with on Table VI, the long intervals between departures tend to disappear. Little by little the continuous service comes into operation which has attained its full expansion between Rome and Naples and above all between Brussels and Ostend. For the first time, we find on the Belgian lines the system of regular train spacing, a train every 3 hours between Brussels and Luxemburg and every hour between Brussels and Ostend.

There are still a number of flag trains running: most are long distance trains as the importance of ultra high speed falls down as the distance to be covered becomes less, the more so as the travellers become more numerous and the number of ordinary trains much limited, stops also being more in number, the time gained by the flag trains is not enough to cover average distances to compensate the cost of the supplement usually imposed.

TABLE VI.

No.	Service	Length km	Traction		Passengers per direction	Number of through trains	Departure time		Number of stops	Minimum time of journey h	Overall speed km/h
			electric km	Diesel km			Direction indicated	Reverse direction			
27	*Oran-Oujda*	253	—	253	?	2	6, 17	4, 9	6 to 24	4	43-62
28	*Tunis-Sfax*	282	—	282	?	3	7, 12, 17	6, 13, 18	20	4.45	60
29	*Vienna-Graz*	260	+	×	?	7	7, 8, 12, 19, 21, 22, 1	4, 6, 8, 13, 15, 19, 23	3 to 24	3.10	40-66
30	*Zurich-Milan*	293	293	—	?	8	**6**, 7, 9, 10, 13, 16, 19, 24	7, 11, 12, 13, 15, 18, **19**, 1	5 to 18	4.30	50-65
31	*Vienna-Salzburg* . . .	312	312	×	?	9	6, **9**, 9, 13, 14, 17, 20, 21, 0	5, 7, 10, **12**, 14, 17, 18, 2, ,3	1 to 18	4	50-78
32	*Brussels-Luxemburg* .	220	220	×	2000 (1)	9	8, 8, 11, 14, **14**, 17, 18, 20, 23	5, 9, 10, 13, 16, **17**, 19, 19, 21	2 to 9	2.30	79-89
33	*Paris-Lille*	258	+	×	6000	10	**7**, 8, 9, **12**, 13, 17, **18**, 19, **21**, 23	**7**, 7, 9, **11**, 13, **16**, 17, **18**, 19, 23	2 to 5	2.30	80-100
34	*Helsinki-Tampere* . .	187	+	×	2000 (2)	10	7, **8**, 9, 12, 15, 17, 18, 19, 21, 24	3, 4, 6, 7, 9, 11, 13, **16**, 19, 21	2 to 4	2.20	60-80
35	*Zürich-Geneva*	287	287	—	?	10-12	5, **7**, 7, 9, 11, **13**, 14, 16, **20**, 0	5, **6**, 7, 11, **13**, 13, 15, 17, 18, **20**, 21, 1	2 to 15	3.15	53-83
36	*Hanover-Bremen* . . .	122	—	×	4700	13	6, 8, 10, 12, 13, 14, 16, 17, 18, 20, **21**, 24, 3	6, **8**, 8, 11, 12, 14, 15, 17, 18, 20, 21, 24	0 to 7	1.15	61-81
37	*Rome-Naples*	214	214	—	6000	24	(3)	(3)	0 to 9	1.45	80-117
38	*Brussels-Ostend* . . .	114	114	×	6000	24	(4)	(4)	2	1.15	92

\+ Electrification in hand or proposed.
× Part operation by railcars.
(1) Occupation of the train in internal service.
(2) Winter in the least occupied section.
(3) Practically unceasing service between 5 h and 1 h; many non stop trains.
(4) Equally spaced service between 6 and 22 h, with some additional trains at peak hours of the traffic and 4 international trains.

The overall speed of the trains remain about the same as before with, however, some tendency to acceleration.

The comfort provided for the passengers is much the same as for long distance runs. Restaurant cars are rarer and reserved to the part of the run covering meal hours. They are not used at all on the shortest journeys of this category but are replaced by snack bar service or trolley service en route. Central corridor vehicles have come into use as well as electric railcars, not often found on lines over 400 km long.

Rail motor coaches are perfectly suitable for limited runs as they facilitate the turn-round of the rolling stock and above all enable the composition of each train to be adopted to meet the passengers requirements. This advantage is particularly valuable on a line with a regularly spaced timetable : the turn-round of the rakes at the end of the workings is often so quick as to make it difficult to alter the composition with hauled stock.

Before we leave the 100 to 400 km lines, we should note that the comparison of the train services on the 33, 37 and 38 lines with a clientele of the same importance shows that in spite of the existence of common characteristics with those of the lines of equal size, there are notable differences in the timetable policies of the Administrations. This difference is particularly apparent when the timetables of 33 and 37 lines, Paris-Lille, Rome-Naples, are compared. The user is the same, the distance equal and the train services are 10 and 24 trains daily respectively.

e) *Short distance traffic (less than 100 km).*

The number of short distance services reported by the Administrations is small and probably it is because in widespread countries such services belong to the suburban category or to secondary lines, or are incorporated in the main lines with longer distance services. It is only in regions of high density of population and when the lines do not end at very large cities that lines of less than 100 km can still show similar characteristics to those of independent main lines.

The operation of lines less than 100 km long (see Table VII) is marked by :

— the number of trains which can reach a very high figure;

— the mixture of through trains, semi through trains and trains stopping at all stations running the whole distance (the stopping trains have not been included in Table VII);

— the high percentage of season ticket holders amongst the users, resulting in marked morning and evening traffic peaks and a great difference between the weekly services, those of Saturday and those of holidays;

— the important proportion of through passengers justifying the running of a greater number of through trains.

Many of these characteristics are found in suburban lines from which it is often difficult to separate them. The most noteworthy case is Brussels-Antwerp, 44 km long connecting two cities with population of one million and half a million respectively and which serves half way a town of nearly 100 000 inhabitants.

Because of the particular features recorded above, the number of stops on lines less than 100 km long varies widely from train to train as does the overall speed. Four track lines are frequently found on railways of this type with heavy passenger traffic. As regards rolling stock it is the same as that described in Chapter 1 for journeys under an hour : it is the exception to find dining cars or even buffet cars. The rail motor coach on the electrified lines is on the other hand quite widely used for the reasons already given.

In Belgium even-spaced timetables are in use on the most important services and the train frequency is at the minimum, one per hour or occasionally even every 30 minutes between 6 and 22 hours. Numerous supplementary trains are run at the peak hours and it is quite usual to reach a frequency of 10 trains per hour over one and the same track.

f) *Timetables on the Netherlands lines.*

The reason for devoting a special paragraph to the operation of passenger trains over the Netherlands lines is the unique character of generalised systematization they reveal.

Let us hasten to add that this organisation could only be applied to countries or territories with a very dense population distributed over the whole territory without too heavy local concentrations. This is precisely the case of Holland with a density of population exceeding 300 per km² and with for an area of 35 000 km² a dozen towns of over 100 000 inhabitants and as many with 50 000 to 100 000.

The train service in Holland can be summed up in a few sentences: the passenger should be given every hour the means of travelling from any one station to another in the country. The services are regularly spaced, at the hour or half hour over the secondary lines as over the main lines: at a junction of average importance the trains coming from all directions arrive at intervals of a few minutes and provide all connections. We can say that the train service in Holland is not only spaced at fixed intervals but that it is also standardised.

The minimum trains run daily is 18 in each direction over all the Netherlands lines; many stops as frequently as needed by the density and distribution of the population over the whole territory; they run frequently therefore, at the speed of accelerated semi-through train; the overall speed is 63 to 83 km/h, made possible by the almost exclusive use of rail motor coaches and rail motor cars with high acceleration.

g) *Miscellaneous.*

1. *Journey times aimed at as a function of the distance.*

The replies of the Administrations to Question 14 (1) ought, it is to be expected,

(1) Question 14: Having regard to the demands of the public and the advances in technique, present and future, what journey time does your Administration think is the most suitable for journeys on your system by passengers in train loads: 300 km, 500 km...

TABLE VII.

No.	Service	Length km	Traction		Travellers per direction (1)	Number of through trains	Number of stops	Minimum time of journey	Average speed overall km/h
			electric km	Diesel km					
39	*Florence-Pisa*	81	81	—	4 000	14	2 to 9	1 h	60-81
40	*Brussels-Mons* (3)	60	—	×	6 000	26	0 to 9	43 min	40-84
41	*Brussels-Ghent* (4)	52	52	—	17 500	47	(2) 0 to 1	31 min	90-101
42	*Brussels-Antwerp* (5)	44	44	—	24 200	64	1 to 9	32 min	55-82

(1) Most frequented section.
(2) Two stops for the train equally spaced of the hourly service.
(3) This line include a section of three tracks.
(4) On the lines reserved exclusively to the through traffic.
(5) This line also has four tracks, two set aside especially and foremost for goods trains.

to reveal important differences in view of the typographical characteristics of the regions served, the technical equipment used and policy as regards speed in force.

Actually the gamut of overall speeds considered covers from 50 to 100 km/h; it is noteworthy, however, that the average of the replies and the majority of these show a speed of 80 to 85 km/h on the distances between 300 and 700 km and 70 km/h on runs of 1 000 km. In the case of the night trains a reduction in speed is considered necessary when the distance is only 300 km so as to cover the greater part of the night.

The French railway system has the most characteristic policy as regards speeds and considers that journeys of 300 to 700 km ought to be capable of being operated at an overall speed of 100 km/h at least. This opinion is shared by the Swiss and Algerian Railways for the distance of 300 km.

2. *The advisability of equal spacing of train timetables.*

We will not enter into the argument as to the spacing of train times : its drawbacks like its advantages are well known, the most important being greater facility as regards the user and the train operation but obligation to operate services which do not pay at periods of little traffic and difficulty of providing paths for goods trains or trains not so spaced such as international trains.

We have perceived that in Belgium and Holland alone is the regular spacing of trains over the main lines been made the general practice. The replies to question 17 ([1]) show that this is in no way due to these two countries having a different idea on the uniform spacing of trains but because their geographic and demographic conditions : short distances, great density of population, lend themselves to this practice. It is not by chance that this practice has been introduced in the most densely peopled countries of Western Europe.

The replies of the Administrations consulted agreed on this subject, spaced train workings are valuable for distances of less than 300 km, when the users are large and sufficiently spread over to ensure each train being sufficiently loaded even during low traffic hours : some fix this number of travellers at 300 to 400 per train although a much lower figure would be tolerable if the working was by means of motor coaches or railcars as these are readily adapted to wide variation in the numbers travelling.

In any event, regular spacing of trains is not attractive if the interval between trains exceeds 2 hours. This opinion is shared by Belgium and Holland in which the minimum interval is 2 hours; the interval of 3 hours on the Brussels-Luxemburg line (Table VI, line 32) being the result of every third train of the hour by uniformity spaced service being extended to the capital of the Grand Duchy.

The conditions causing or rejecting regular train spacing in the timetables is most exactly defined by the Belgian reply to Question 17 as follows : « The frequency of departures in a regularly spaced train service necessarily depends upon the distances separating the most important centres served. We consider the time between two successive departures should be less than the time an automobile would take to travel between the two centres. As soon as the traffic is too little to feed such a service, we think there is little value in adopting a regularly spaced train service. »

3. *Utilisation of rolling stock and meeting the needs of the users.*

The timetables issued by the Administrations should meet in particular the double objective of satisfying the public and making the optimum use of the rolling stock. From the replies received in most cases, this double objective has been reached without any major conflict and has been facilitated

([1]) Question 17 : If the users justify a service spread over the whole day, do you think it desirable to arrange the timetables at regular intervals; starting from what frequency ? Give reasons justifying your reply.

by the change of traction in recent years. In those few remaining cases of incompatibility, the problem has been resolved by giving to the greatest possible extent preference to the satisfaction of the travelling public. Shortage of rolling stock alone could justify any other attitude in face of such a conflict of interests.

CHAPTER III.

Operation of secondary lines.

a) *The conditions governing the timetables.*

The users of the secondary lines are made up of two classes of passengers, those whose journey is limited to the line concerned and those who use the secondary line only at the beginning or end of their voyage as a complement to the journey over the main line.

The preoccupation of these two categories of users differ completely : the local travellers want their voyage to be at favourable times, whereas the others are anxious about a quick connection at the junction station with the main line trains.

In the case of secondary lines of heavy traffic, all the users can be satisfied easily : this is not so on the lines of light traffic which are the majority.

The policy of the Administrations generally gives preference to the problem of ensuring the connections rather than to meeting local demands : there are exceptions depending on the character of the particular line. Thus it is not unusual at the times of peaks of traffic, that trains which are not favourable for fast connections are run to serve important localities, industrial and agricultural centres : at times of light traffic when it is much less imperative to serve local centres, a return to the policy of good connections is adopted.

The policy of providing easy connections with the main line can moreover be developed much further still should the number of travellers justify it. Connections then are replaced by the pure and simple extension of certain main line trains over the secondary lines and vice versa. This practice which makes the distribution of the train services — though on a reduced scale — like that over the Moscow-Tbilissi line is rather rare and remains in most of the cases in which it is applied limited to the peak traffic hours.

b) *Frequency.*

The Administrations questioned on their policy as regards frequency have given widely differing minimum figures, that is from two trains per day to one train an hour : most of the railways estimate that three trains a day is the strict minimum and on main lines this figure has been raised to 5 and even more.

Certain railways only run trains when they are certain of a minimum number of passengers : they recognise that in thinly populated areas, provision has to be made for exceptions and that the profitability of all these trains is far from certain if a minimum of satisfaction is to be given to the customers.

Other railway Administrations place the accent on the need to compete with road transport and on the contrary prefer to run partly or generally by road in the case of the least frequented lines. Without taking sides in favour of one or the other, as the solution of this question is outside our enquiry, we will point out however that many attractive combinations of timetables have been arrived at on certain railway systems by using both rail and road.

A typical example is that of certain Belgian secondary lines with a relatively important number of travellers : semi-direct trains run every hour or every two hours on the secondary line and ensure connections with the regularly spaced service of the main line at its end; these semi-through trains stop in the most important stations of the line and there make connection with a road motor bus service which collects and distributes the local users. A notable acceleration of the traffic is secured by this organisation whereby a passenger has

only a minimum number of kilometres by omnibus to get from a small village to any large city of the system or vice versa.

c) *The speed.*

The maximum speed authorised on secondary lines is nearly always or sometimes much lower than that of the main lines. In certain countries, as in Germany (D.B.) this speed is limited by law.

As regards the overall speed, the considerable number of stops due to crossings on the lines which are mainly single track, the limitation of maximum speed, and the rolling stock in use, result in it rarely exceeding 40 to 50 km/h.

Efforts have been made to raise it by many Administrations, the case of Belgium being quoted earlier. Other Administrations are putting into service high speed railcars or motor coaches in between trains hauled by locomotives usually slower. Acceleration is considered desirable but has to be kept within limits if the cost of maintenance of the track is not too increased.

d) *Comfort and rolling stock.*

Even though certain Administrations consider the comfort should equal that on the main lines, it is difficult to avoid the rolling stock used on the secondary lines being older, the normal tendency of the systems being to allocate the new rolling stock to the main lines and to turn over the old stock so freed to the secondary lines. There are many who consider improvement desirable but are still suffering from the aftermath of the Second World War during which large accumulations of renewals built up.

Nonetheless, if the presence of old rolling stock is seen amongst the coaching vehicles, the railcars and motor coaches on the secondary lines are often more modern. These units tend to multiply whether they run alone, with trailers or coupled together. They adapt themselves more readily to changes in passenger movements, provided these variations remain within certain limits and that their low purchase cost enables the service of trains to be covered by them : in this way they can be used intensively.

Without going to the length of scrapping all the old stock on the secondary lines, we think it desirable to have available 4-axled metal vehicles with centre corridor, possibly with upholstered seats in the 2nd class and comfortable motor coaches or railcars possibly of one class for medium length journeys. In the case of only some very long runs, unusual on secondary lines, the presence of a snackbar or in the last extreme a restaurant car can be justified.

As regards road and rail vehicles some trials have been made but the units do not seem to have given satisfactory results, the loss of time changing from rail to road and vice versa being too great.

CHAPTER IV.

Suburban traffic.

We cannot begin here to deal with, in its complexity, the problem of serving the suburbs of the great cities. To do so would be to overstep the fixed boundaries of our report and moreover the needed information would be lacking as for example that relating to urban transport properly speaking and which could not be ignored in any complete study. This chapter therefore will only consider the aspects of the problem of suburban transport relatively to the general subject of Question 6.

a) *The users and fluctuations thereof.*

The passenger traffic of suburban services to cities of over a million inhabitants is essentially a mass movement reaching figures up to several hundreds of thousands of passengers a day.

The traffic peaks occur morning and evening between 7 and 9 and 17 to 19 or 20 hours and to a less degree at mid-day between 12 and 14 h. At the highest peak period, the number of travellers to be carried is frequently ten times greater than

during the quiet times of the morning and afternoon. These peak periods of traffic as regards the Administrations concerned present extremely difficult problems requiring complicated equipment to deal with them.

b) *Type of traction.*

Although all systems of traction are to be found in suburban workings, electric traction has been most frequently introduced for this class of service to which it is particularly suitable especially when motor coaches are used. Many schemes have been developed for electrifying suburban services not yet converted.

We have to point out however that important suburban lines have been and still are worked by steam traction and in particular by reversible rakes which can be worked equally well from the locomotive or from the opposite end of the train.

c) *The timetables.*

The problem of departure times does not arise in actual working as the suburban services as a general rule have at least one train per hour leaving between 5 hours and midnight.

At the slack periods, the service is usually one stopping at all stations from one end to the other, but at peaks the railway Administrations either run through trains or semi-through trains with few stops and occasionally adopt combination of timings enabling them to intensify to the maximum the train service as for example timetables formed like a network repeated at close intervals in the same form and making provision for serving stations A to D, a through train to D followed by a through train to C and continued as a stopping train to D, then a through train to B continued as a stopping train to C, etc.

The timetables are arranged at regular intervals when the suburban lines are independent of the main lines or when the timings of the long distance trains running over the same lines are also arranged at regular intervals.

d) *Connections.*

The users of suburban lines are essentially local travellers, attracted by the large centre which consumes much labour; consequently, connections with main line trains are not as a rule looked for. On the other hand, they are often automatically given as a result of the frequency of trains departing over the important suburban lines and in particular at peak hours.

Some railways however do take into account connections, a notable example being the Moscow suburban service of the U.S.S.R.

e) *Overall speed.*

The suburban services are mainly stopping or semi through trains and the speed hardly exceeds 60 km/h or usually about 35 to 40 km/h. This speed wins the comparison with that of other means of transport circulating over congested streets in large centres of population.

f) *Rolling stock and comfort.*

In view of the importance of the traffic peaks, it is not possible to give every passenger a seat at the rush hours. Most of the vehicles have a limited number of seats and are provided with large platforms. The U.S.S.R. Railway Administration reports that it puts into service at the peak hours for a short period carriages with no seats. Most of the trains have compartments of both classes, the vehicles having centre corridors with or without intercommunicating gangways.

The motor coach is frequently used on electrified lines as it makes it possible to adapt the train make up to suit variation in passenger traffic and also speeds up the turn round at terminals.

The stock has been lightened as much as possible to make it possible to get quick starts and so attain high enough overall speeds.

g) *Tests to spread over the traffic peaks.*

The Railway Administrations are helpless by themselves to spread over traffic peaks although this would relieve the working

of the suburban lines and would enable the comfort of the passenger to be improved.

Some of them have tried to persuade the public authorities and private business firms to spread the hours of opening of offices and stores but usually unsuccessfully, except in U.S.S.R.

In Denmark, trials are in hand in another direction : the reduced fare tickets are available for journeys made between 10 and 15 hours from Monday to Friday : the Danish Railways are not yet able to establish the results of this very interesting experiment.

CHAPTER V.

General Conclusions.

The Railway Administrations during the last ten years since the end of the second World War have continued to seek the lowest cost of passenger train working.

Their efforts have been directed to several fronts but more particularly towards reducing the cost price of traction by a change in this and toward the concentration of the traffic by reducing relatively the number of trains run.

The increase in the numbers travelling fortunately has made it possible to conciliate at the same time the exigencies of the public which clamour for a frequent train service and the railway interest anxious to improve its earnings.

Nonetheless, the competition from other means of transport has shown itself to be particularly active : even if the number of passengers by railway in total increases, it cannot be overlooked that the part played by the railways in the whole transport field is declining.

Aircraft offers incontestable advantages in long distance transport. It still addresses itself rather to the better off travellers, those who previously travelled first class, but there are obvious signs of its democratisation.

The helicopter has appeared in civil aviation to a limited extent only, but where such services have been started the newcomer has shown its value in medium distance traffic over 200 km in passenger service. Its small capacity does not enable it to be a dangerous competitor for the railway at present but its possibilities appear to be far from being exhausted.

As regards the autobus; its rise is notable, but in Europe at least it remains, as a rule, confined to short distance operation, and in this field does not seem adapted to moving masses of people. The growing congestion in the cities which form the issue of mass transport moreover opposes the development of such urban traffic by motor omnibus. None the less in many cases the motor omnibus reveals itself as a better revenue earner on low traffic secondary lines than the railway where there are no marked traffic rushes.

The private motor car finally has taken from the railway part of its old clientele but a victim of its own growth commences in certain countries especially with high density of population to show signs of choking itself. There are many cases of passengers returning to the railway who, travelling between large centres, had been irritated by the congestion on the roads and the difficulty of parking in cities.

In spite of everything, the railway is called upon to fight on all fronts and its field tends to shrink. In the domaine still its, however, its users have increased in large measure, this being in services with large numbers of passengers, on which high capacity trains can be run and frequently enough. We have seen this was the case on the lines connecting areas of large population generally less than 1 000 km apart and especially on less than 400 km, on secondary lines with heavy traffic, and on suburban lines.

Without for this reason abandoning the other services to themselves, and particularly when the public interest requires the co-existence of several forms of transport the major efforts of the railway systems should be devoted to their more valuable lines to impove the train service in order to retain the traffic and then to increase the number of their customers.

Constant vigilance is essential and ought to be devoted in varying degrees to the main fields which are the enquiry into the optimum departure and arrival times, the selection of frequencies and speeds, and improvements in comfort always whilst remaining within the limits of profitable working.

The replies of the Administrations to Question 6, as dealt with in the preceding chapters, show that in spite of sometimes considerable divergencies of conception and of extremely diverse operating conditions, it is possible to bring out, in the field of the technics of timetable preparation, a certain number of rules or at least tendencies summarised below.

1. The consistency of the train service on long runs does not depend only upon the size of the centres served and the distance between them : the duration of the journey and the comfort given the travellers have also a decisive influence.

Thus passing political frontiers causes the trains to make long stops for customs formalities or changes of motive power : to these material difficulties we have to add the economic, physiological and frequently linguistic obstacles the frontier forms. This obstacle has the same effect from the railway point of view, as a lengthening of the journey time.

This is why we notice in the classification of trains by frequency that the international trains are most often relegated to an inferior category to that of similar internal trains.

2. The Administrations should force themselves to reduce the losses of time prejudicial to the good user of the trains by making the customs and police controls on the journey general practice, and in electrified services by providing locomotives able to operate on all kinds of current.

3. The Administrations have adopted different frequency policies so much so that important variations can be noticed between the number of trains run on lines presenting otherwise equivalent conditions as to the number of users and of times of journey. The general tendency nevertheless is to economise train kilometres and the increase in travellers which has continued for several years has not been followed by a proportional increase in the train services. The railway directs itself more and more to *long distance traffic* and to operating with heavy trains, a field in which no other method of transport can compete.

4. The selection of the times of departure and arrival of the trains should take into account, in priority, the two following objectives :

— reduce the encroachment of the voyage on the normal working hours and with this object in view favour travel by night, in the evening or during the afternoon;

— avoid train departure or arrival between midnight and 6 hours.

5. Consequently, for journeys of over 6 hours and when considering successively routes the users of which justify the running of one, two, three, four... trains per day (1), it is desirable that the timetables include commulatively, in the order indicated the following trains :

— a night train leaving between 19 and 24 hours;

— a day train leaving in the early hours of the morning (for journeys of under 16 hours);

— an afternoon train (for journeys of under 12 hours);

— a flag train leaving between midday in each direction or the morning in one direction, and the late afternoon in the reverse if one extremity of the run is favoured relatively to the other;

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(1) In this part of the Chapter : Conclusions, by trains is meant a single convoy or a group of several convoys over the same route following one another at short intervals, thus all trains leaving point A at the end of the evening to reach point B during the early hours of the morning will be included under the vocable « the night train ».

— other trains, the departure of which depends more directly on the particular condition of the line.

6. If the journey time is less than 6 hours :

— the night train is replaced by an evening train;

— the departure times of the day train will be selected to ensure the whole journey being made in half a day, morning or afternoon including the midday meal;

— the flag trains will continue to be used on the longest run but will be replaced on the others by through trains carrying all classes of passengers.

7. The consistency of end to end traffic is not always enough to justify the running of more through trains. In this event, the important thing is to take care to provide a reasonable number of trains when numerous intermediate stops are made in order to ensure the trains being sufficiently well loaded.

The running of flag trains on lines of average user acts as a corrective of the drawbacks of this policy on long distance journeys.

8. On heavy passenger traffic lines when the time of journey is reduced, all categories of users can be satisfied by giving them a service made up of both through and semi-through trains at a satisfactory frequency : the value of flag trains then becomes slight.

Against this, in countries or regions with very great population without too great concentrations, the choice may be, preferably, a semi-direct service with high frequency.

9. Improvements in frequency and speeds possible through change of motive power have generated new traffic particularly in highly populated countries or regions. The technique of uniform train spacing should hold the attention of Administrations where the conditions are favourable to the growth of traffic.

As a first approximation, it can be considered of no value to space trains regularly, when the minimum interval allowable between two succeeding trains exceeds the journey time or is over 2 hours.

The estimation of the minimum level of users for justifying running an additional train depends largely on the type of stock considered : operation by small capacity motor coaches with units able to operate in sets is the type that can extend the field of regular train spacing to short distance traffic.

10. The greatest efforts are to be tried to improve the comfort of the journey : two snags, however, are to be avoided :

a) an exaggerated surface assigned to each passenger which reflects itself sooner or later by a corresponding increase in the number of trains to be run for the same number of passengers;

b) a too marked reduction in the additional comfort reserved for the higher class which would accentuate the flight from its higher price.

11. On the main lines it must be considered indispensable to provide the passengers with the following :

— all metal vehicles on 4 pairs of wheels or of equal good riding qualities, with centre corridor for short runs, side corridor for runs over 3 to 4 hours and with upholstered seats in the lower class;

— lying down seats, beds or fitted bunks in sufficient numbers when the night journey exceeds 5 hours;

— a snack bar or a trolley service selling food stuffs on runs of 2 hours and over;

— a restaurant car or at least a buffet, at meal hours when the journey exceeds 3 hours.

12. In the case of new stock it is recommended :

— to use seats, the shape of which is scientifically designed to reduce fatigue;

— to improve the heating, lighting, and especially sound deadening and springing.

13. The choice between hauled stock and motor stock can be based on the following conditions :

— high degree of comfort is more easily obtainable with hauled stock than with rail motor coaches;

— rail motor coach trains are the right choice only if a continuous use of the stock is certain either because the travellers are sufficiently spread over in time, or because the peak hour trains are worked by hauled trains;

— motor coaches offer certain advantages of their own of which advantage can be taken on short runs : readiness with which the composition of the train can be adapted to the users by constituting convoys with multiple units, and possibility of intensive user by reducing the idle time at the ends of the journeys.

14. On secondary lines it is to be hoped that :

— in regions of average or low population density, a minimum of three trains a day be run in each direction;

— most of these trains, and a greater part the more the service is reduced, make connection with the main line trains at the junctions.

15. The use of motor coaches is the solution the Administrations frequently adopt to be able to run by rail a sufficiently attractive service on lines with few passengers and good results are also obtained by a combination of railway train and road omnibus on lines of average frequentation.

16. On secondary lines with short runs, a degree of comfort equal to that given on the main lines cannot be required. It is however undesirable to maintain too wide a contrast between the two categories of lines.

17. The suburban lines (1) are characterised by marked peaks of traffic which cause growing operating difficulties and can only be absorbed by very burdensome arrangements. This situation is also found on city transport systems and in road motor traffic.

This accentuation of peaks of traffic consequently causes anxiety equally to the Public Authorities of the great cities and to the transport companies and motoring associations who have the same desire to see them spread over longer hours. This unusual common interest ought to be profited by and a common front built up to seek possible solutions and develop a campaign to interest the higher administrative levels of the State and of undertakings with a numerous staff or even ultimately to appeal to public opinion.

18. Exclusively railway solutions to the problem of traffic peaks perhaps are not impossible, at least on a reduced scale. It is to be recommended that the Administrations who have made experiments on such solutions should diffuse the results through the great Railway Associations.

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(1) Many short distance main lines end at large cities and are also subjected to such traffic peaks.

[656 .222 .5]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 6.

When changing over to electric and Diesel traction for passenger train services, research of the principles which may lead to a rational and efficient organisation of same.

For this purpose to :

- **work out the social and economic needs and with this object in view, classify the passenger services according to the needs of the populations served, the distances, the volume of passenger traffic and its variations;**
- **fix, for each category, the traffic hours and advisable frequencies as well as the reasonable requirements of the public for comfort and speed;**
- **define the most suitable methods to draw up the timetables (including eventually regular interval train services) : choice of the type of train and rolling stock, fixing the runs.**

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, India, Irak, Iran, Republic of Ireland, Japan, Malaysia, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden and the United Kingdom of Great Britain and Northern Ireland and dependent overseas territories),

by G. F. Fiennes,

Line Traffic Manager, Great Northern, British Railways.

INTRODUCTION.

1. Comment on terms of reference.

By definition the question is, and therefore the answer must be related to the social and economic needs of the populations served. Few railway administrations can afford, and fewer still are allowed, to take so single and high-minded a view of their passenger services. Other motives intrude — private profit, contributions to national revenue and to social benefits for their workers, alleviation of an unemployment problem, strategic requirements, security precautions, advertisement for freight services, and so on, and so on. Nor is it easy to study the principles of passenger services apart from the influence

upon them of other forms of transport by land, sea, and air.

2. Acknowledgment.

Fourteen administrations undertook the task : the State Railways of India, Japan, Norway, New Zealand, Burma, East Africa, Ceylon, Egypt, Ireland, South Africa, Sweden, Great Britain, and the privately owned Long Island Railroad and Malayan Railways.

May your reporter thank the administrations for their thoughtfulness in returning prompt answers and many of them for the evidently great trouble and thought which they have devoted to the question.

3. The only similarity between the problems of the fourteen administrations appears to be that each operates a railway. The variation in the density of population which they serve is nine times; in the service which they provide is two hundred times; in the use which the population make of the service forty-three times. Climate, terrain, economic development range from one extreme to the other.

The only common ground — and it is a marked advantage — is that the reporting administrations are generally self-contained politically. In few cases do their passenger services cross a frontier. The problems which arise from the activities of the Customs and Police are negligible.

GENERAL APPROACH TO QUESTION.

4. The report will study the principles of a rational and efficient passenger service under five heads :—

Convenience	: Hours of service : Frequency : Structure of service : Publicity.
Reliability	: Punctuality : Certainty of operation.
Speed	: Overall speed rather than maximum.
Comfort	: Noise : Quality of riding : Temperature : Personal position.
Cheapness	:

There is a sixth principle, Safety, with which in their extreme ranges speed and cheapness conflict. In this study Safety will be taken for granted.

The report is arranged :—

Introduction;

General Approach to Study;

Classification of Passengers by demand;

General Approach of Administrations to the demand;

Study of the five principles;

Conclusions.

The report attempts to summarise the significant features of the services quoted by the administrations and the views on general questions expressed by them. There has been a free use of quotation and in view of the well-known dangers of quotation in a narrow context the reporter trusts he has used the method fairly. He has interpolated views of his own from time to time without in anyway committing British Railways.

5. In order to avoid complication, the five principles are studied in two groups : firstly, the express services; secondly, suburban services.

6. Firstly, however, a general principle. Broadly, travel by rail is a waste of time, in the sense that the passenger is travelling with the object of arriving and until he arrives he does not achieve his object. Therefore, convenience, reliability, and speed directly and evidently are related to his object; comfort directly, but less evidently, as conducing to his arriving in a condition fit to achieve what he has set out to do. Railways should in their timetables, if animated by the social and economic needs of their passengers, provide a safe, convenient, fast, reliable and comfortable service.

7. That such a service can also be cheap has been demonstrated by a number of administrations.

CLASSIFICATION OF PASSENGERS.

8. Secondly, it is necessary to classify passengers according to the object with which they travel, so that a balance can be arrived at between the claims of speed on the one hand, comfort on the other; or speed and comfort on the one hand, cheapness on the other; which things conflict in at least their extreme ranges. Reliability, like Safety, is absolute and not to be compromised by a devotion to speed.

9. The classifications of passengers which appear collectively from the reports of the various administrations are :—

a) Workers travelling to and from work.

b) Business men travelling to and from their offices.

The demand in (*a*) and (*b*) is regular except during the weekly and public holidays. It varies somewhat in different countries in point of time in the morning and evening.

c) Business men, Government servants, commercial travellers and the like travelling to and from meetings, inspections and sales.

The need for travel in these categories is regular, virtually throughout the year except during the weekly holiday and during the public holidays.

d) Students and schoolchildren travelling to and from study.

This category demands regular transport but during the school terms only, with the proviso that in some countries, Britain and Kenya among them, there is a significant peak demand for a few days when the boarding schools begin and end their terms.

e) Housewives and casual travellers by day for shopping, visits to places of culture, and the like.

The demand here is small but regular with, generally, a weekly peak according to the market day in the nearest town, or an irregular peak when some particular attraction stimulates travel.

f) The public generally travelling in the evenings for entertainment.

This demand varies with the level of attraction and the incidence of pay day.

g) The public generally travelling to particular attractions : football, horse racing, motor racing, the seaside, and the like.

A spasmodic and often burdensome demand which varies widely from time to time and from place to place.

h) The public generally travelling during their annual holidays.

The demand here is for travel from home to the place where the holiday is spent, and possibly from place to place during the holiday. This demand is a high peak during the months when the weather is best for the purpose of the holiday. There is, for instance, in Norway a subsidiary peak in the winter for ski-ing : during those months it is also at a high peak on particular days in the week when works and offices close for the weekly holiday. In some countries there is also a geographical concentration when a works, a colliery, or indeed a whole town shuts down for a simultaneous holiday.

i) In the case of India the public generally travelling to sacred festivals.

10. Of these demands some are for travel generally over short distances only — categories (*a*), (*b*), (*d*), (*e*), (*f*). Others generally over long distances — (*c*), (*h*), (*i*). Category (*g*) is a mixture of short and long distance demand.

GENERAL APPROACH OF ADMINISTRATIONS TO DEMAND.

11. The background against which these demands are set can be illustrated by a table which shows the number of journeys per year per inhabitant of the various countries, and the distance travelled.

TABLE I.

Journeys per year		*Distance (km)*	
Over 40	*Japan* (43)	80 — 89	*Malaya*
35 — 39		70 — 79	
30 — 34		60 — 69	
25 — 29	*Britain*	50 — 59	*Sweden*
20 — 24		40 — 49	*India* *Ireland*
15 — 19	*Sweden*	30 — 39	*Burma* *Egypt*
10 — 14	*Norway*		*Norway* *Britain*
	New Zealand	20 — 29	*Japan* *Ceylon*
5 — 9	*Egypt*	10 — 19	
	Ceylon		
0 — 4	*Burma* *Malaya*	*NQ*	*South Africa*
	India *Ireland*		
	South Africa		

N. B. — Information on distance from *New Zealand*, 138 km is for long-distance only and is, therefore, not tabled. — *NQ* = not quoted.

12. On the other hand it is important to correct these figures of the individual social demand by each nation on its railway administration by quoting the actual task which the administrations undertake in terms of passenger journeys. In these figures three years are quoted, one immediately pre-war, one immediately after post-war recovery, and one recent year. For almost all the administrations the demand, and therefore the task, has increased — in many cases increased enormously.

TABLE II. — **Passenger kilometres (millions).**

Country	*1955/56*	*Percentage increase*	
		1955/pre-war	*1950/pre-war*
India	62 404	206	222
Britain	33 343	109	107
Japan	31 564	369	242
Sweden	6 163	188	203
Egypt	4 287	316	204
Norway	1 556	223	222
Ceylon	1 375	N.R.	N.R.
Burma	792	110	23
Malaya	591	N.R.	N.R.
Ireland	442	N.R.	N.R.

N.R. = no record.
Not tabled : *New Zealand : Long Island : South Africa.*
Index for 1935/40 = 100.

The service which the administrations provide for this task may be very broadly indicated (very broadly because there are all kinds of reasons for the variations) by an index of the Passenger train kilometres run per inhabitant per day.

TABLE III. — **Standard of service.**

	Passenger train km per inhabitant per day
	Index figure
Great Britain	1 000
Japan	700
Ireland	700
Sweden	400
Norway	200
South Africa	60
Ceylon	20
Egypt	20
Malaya	10
India	10
Burma	5

Not tabled : *New Zealand : Long Island.*

13. The public demand.

At this stage we must distinguish between the public demand, a phrase which has been in use in the preceding paragraphs, and the public need. The public demand is almost always selfish, whether it is expressed individually or collectively, whether by letter, word of mouth. through the press, through people influential in railway or political administration. « Nothing could be more convenient » it has been said recently in Britain, « for a person who wishes to travel once a day than a service every five minutes, unless it be a service every two minutes ». If to this trenchant dictum on frequency there were added an equally trenchant dictum on speed and the number of intermediate stops between origin and destination, there would emerge a picture of the public demand exaggerated in degree only. Henceforward any reference to public demand must be construed as referring only to public need.

STUDY OF THE FIVE PRINCIPLES: I. CONVENIENCE.

14. The Convenience of a service can be studied under the broad heads of the hours between which the service is running; the Frequency and Structure of the time-table; and the Method of presentation. Main Line and Local Services are treated separately.

15. Hours of service. — Main line.

On the hours between which a regular main line service leaves its originating terminal, (the reporter attempts no definition of long distance or short distance in order to avoid a conflict between, say, South Africa and India on the one hand and Ireland and Britain on the other) — there is broadly unanimity.

(Appendix « A » shows the preferences of the main line administrations for journeys between two and twenty-four hours). In the morning, passenger services begin between 6.00 and 8.00. Only Burma, Egypt, Sweden and India recommend departures as early as 6.00; Sweden for short journeys between three and six hours where an outward and return journey is possible in a day; India for a journey of fifteen hours. For night journeys the latest time of departure generally acceptable is 23.00 and many administrations accept this time with reserve, preferring between 21.00 and 23.00. The earliest arrivals recommended are 5.00 though the general preference is for 6.00 or later, and the latest for day journeys 23.00.

16. Within these limits there is a wide field for manœuvre. The people who use main line services tolerate more than local passengers some regulation of their habits by the time-table. And in countries

where either the population or the habit of travel is insufficient to support a frequent service, the railway administration has no choice but to regulate passengers' habits in their normal course of concentrating individuals with their individual demands into train loads with a collective need.

17. Hours of long journeys.

For the longer journeys the emphasis is on travel by night. New Zealand runs two express trains between Auckland and Wellington. « The departure times... are arranged so that the greater part of the journey is made at night and passengers reach their destination early the following morning... The stopping times at intermediate stations are naturally subordinate to this factor ». Burma : « ... the most convenient hours of departure are... for night trains so that the arrival will be in a reasonable hour ». India : « ... people generally prefer to leave as late as possible in the evening and arrive at the destination at a convenient time after day-break. (Only) where more than one mail or express train runs between the same two points one of the two is scheduled to leave during the day ». Egypt : « The distance between terminals (on the Cairo — Assuit Line) being relatively long most of the passengers prefer night travel and so benefit the day for business and pleasure ». Japan, on the line from Tokyo to Osaka runs ten out of nineteen Limited or Express trains through the night : in Britain between London and Edinburgh there are six by day and six by night.

18. For journeys by night a convenient time of arrival appears to be dominant. Norway quotes a tolerance of one hour only 5.00 to 6.00; Sweden and Britain of three hours — 6.00 to 9.00; New Zealand and Burma have already been quoted in this sense. Appendix « A » appears to support the same conclusions for India.

19. Hours of shorter journeys.

For journeys up to six hours Sweden epitomises the general feeling by assuming that the return journey can be made by day in the same day and by declaring these objects :

Working day starting at 9.00 a.m.

Congress or business meeting starting at 10.00 a.m. return journey after meeting during the morning.

Congress or business meeting starting at 1.00 p.m. return journey after working day or afternoon meeting.

Evening leisure journey, theatre, concert, return journey after theatre, concert.

Britain adds : « avoid departures too early in the morning and arrivals too late at night ». « Give... the traveller four to six hours for business ». Ireland seems to have a particular preoccupation « to give timely arrival at destination for lunch » but it is fair to say that this is allied to a reduction in the standard of catering on the trains. Once again the time of arrival appears to be dominant. But in the contrary sense India and Norway, the latter alluding to her express specials 61 and 62 « the hours of departure have been set to allow as much time as possible during the business hours. A late departure has been the prime consideration in the planning of these timetables while the late arrival at destination consequently has been of less regard ». The arrivals are in fact 22.45 and 23.00. In Britain also recently there have been two experiments in the same sense in the introduction between London and Scotland — 650 kms. — of the Caledonian from Euston at 16.15 and of the Talisman from King's Cross at 16.00 due at Glasgow and Edinburgh at 22.55 and 22.40 respectively. So narrow is the margin for connection with local transport at destination that the train with the earlier arrival is very considerably the more successful.

20. For journeys over six hours and within the limits of an earliest departure at 7.00 and a latest arrival at 23.00 and of the tolerance of mankind to fatigue in travelling, an outward and return trip in one day is generally disregarded by the administrations. A total outward journey of sixteen hours is possible and Sweden, India, Japan either already undertake or recommend journeys of this length.

21. For journeys between six and eleven hours it is possible for the traveller to occupy the morning up till 12.00 or later and arrive at his destination at or before 23.00, but it is significant that the maximum journeys recommended by the administrations in the afternoon are :—

Britain, Japan, India	:	10 hours
Sweden	:	9 hours
Egypt, Norway	:	8 hours

In contrast with some administrations' habit of booking a train or group of trains leaving in the afternoon for journeys between six and eleven hours is the Japanese time-table from Tokyo to Osaka. There is no Main Line Express between 13.00 and 18.30 based evidently on the principle of giving a latest arrival at or before 23.00 before starting a night service. This gap of 5 1/2 hours exists though the average frequency of the service is almost a train an hour overall and between 9.00 and 23.00 nineteen trains in fourteen hours.

It is a likely conclusion that there is a field for further development on the lines adopted by Norway, Sweden and Britain of high speed services over long distances in the afternoon. To the relation between time, so far discussed, and distance your reporter refers in sections 51 to 56 of this report.

22. Frequency and structure.

In sections 14 to 21 this report has treated journeys as being broadly from terminal station to terminal station, but of course to leave it at that is entirely unrealistic. A journey from the social angle is from the place from which the traveller wishes to start to the place at which he wishes to arrive; home, office, conference, theatre, place of pilgrimage, school and so on. As has been said the passenger who uses main line services has great tolerance and it is to his clear economic advantage that railways should concentrate their passengers in trains with as high a load factor as possible. On the other hand, where people come to join main line trains or travel after alighting from them for varying distances and by varying means of transport, a choice of times of departure and arrival by the main line train is a clear social advantage.

23. This brings the report to a discussion of the general structure and frequency of the time-table. There is a useful broad division into type of time-table which can be called Group and that which can be called Continuous. A Group time-table is one in which either single trains or a group of trains run at particular times of day leaving long gaps with no service. A Continuous time-table is one in which the trains are spread reasonably evenly throughout the hours of passenger service. By a further refinement they may be spread exactly evenly in which case the service is known as an Interval Service. The last refinement of all is the National Interval Service in which the time-tables for all main lines and branches are interlocked in a precise and even pattern.

24. Which choice each administration has adopted depends to some extent on considerations which this report must ignore : such as the demands on the capacity of the line by freight trains, engineering maintenance and the like. The principal features of the services which this report studies are set out in Appendix « B ». The countries which run a Group service are Norway, Malaya, New Zealand, Burma, South Africa, Ceylon, East Africa.

The countries which quote both Group and Continuous are Sweden, Ireland and Egypt. The countries which run Continuous services are Japan, India, Britain. Britain is the only country which quotes an Interval service. It should be understood that any or all of these countries may have time-tables of other types but have not chosen to use them as illustrations.

25. The first quotation on frequency is one on Air Transport, from a paper on European Air Transport Economics in 1957 by Mr. Stephen Wheatcroft. « Frequency is very important and the frequency requirement is related to the journey time simply because the saving in time that higher speed makes possible is only useful to the passenger if the service gets to his destination at the time he wants to be there... It is not difficult to ascertain the frequency which can be said to satisfy the requirements of the bulk of the traffic and once this frequency has been reached there is great advantage to my mind in increasing the size of the aeroplane rather than to continue to increase frequency. When faced with a marginal choice between size and frequency I would always advocate the use of a larger aeroplane on the grounds that larger size will produce lower costs, lower costs will enable lower fares to be charged, lower fares will attract more traffic and more traffic will enable the frequency to be increased ».

26. Advantages of « Group » structure.

Interpreting what satisfies the requirements of the traffic as to Frequency, India writes : « It is not considered feasible to introduce timetables on a fixed interval basis throughout the day for the reasons that passengers emanating from large towns... like to leave either in the morning or late in the evening, consequently the practice of running non-suburban passenger services in a group... ». Egypt also : « Cairo being the capital and centre of most of activities in Egypt a service leaving early in the morning and another immediately after the closure of Government Offices run to Assuit ». Burma : « If the number of passengers justify a Continuous service throughout the day a time-table on an Interval basis for local trains would have many advantages... If applied to longer distance trains there will be many snags and disadvantages which would outweigh the advantages ». New Zealand has already been quoted in Section 17 in the same sense.

27. Norway and Sweden are also in the Group category but for a different reason, international connections by ship and train, as is the Southern Region of British Railways with its service between Paris and London.

Norway : « The schedules of the Oslo-Bergen Railway being a link in the Inter-European Services have to take into consideration the connection communications at Oslo and Bergen (to Newcastle and other overseas ports) as well as coastwise and other domestic routes. In Oslo the trains are scheduled to connect with other internal routes. At intermediate junctions there are regular bus and fjord steamship services to consider ».

Sweden confess that in several respects their time-table is an unsatisfactory compromise between conflicting demands and « has complications with international connections, mails, line occupation by local freight services ».

In all these cases, therefore, the passenger services are designed to meet the greater specific and often complex demand at particular times of day and to channel the lesser demand to the service rather than to spread the service evenly throughout the day with the object of satisfying a demand within a short time of its arising at whatever time it arises. This, as readers will readily detect, is an oversimplification but is still a broad truth.

28. Advantages of continuous service.

In the second sense of spreading the service evenly and continuously is Egypt in her service between Cairo and Alexandria (which are) « the main centres of Egypt: the first is the capital and the second is the main city and harbour, and thence the big business between. This needs a frequent service at all times of the day but increased in the morning and after hours of Government Offices in the afternoon ». Britain on her service between London and Brighton « as the services are generally on an even-time basis throughout the day all requirements are met ». On her northern services, « the vast majority of the journeys are four hours or less and for these a frequent service is essential giving ample freedom of choice to suit individual convenience ».

29. Discussion of interval service.

The distinction in the phrase « Continuous Service » between a frequent service and an interval service is not of great moment at the terminal of origin. If the service is frequent, then the alteration of the times of departure evenly at so many minutes past each half hour or each hour, or each two hours is a simple aide-memoire to the traveller.

30. An interval service is a service in which each of a series of trains spread throughout the passenger day is timed throughout its journey at an even interval after each hour. An eventime departure service is a service in which each train leaves its starting point at an even interval but may vary from the rest at any subsequent station.

31. The case for and against either of these services is :—

firstly, that they are easy for the public to memorise — always provided that the interval is sufficiently short. This advantage applies to the originating station only for eventime departure services.

secondly, that they promote higher frequencies by inducing administrations to run extra trains for the sake of completing the pattern and indeed by affording — if the timetable is an intelligent one — a cheap means of doing so.

thirdly, they enhance prestige by their appearance of good order and good planning.

fourthly, they conduce to punctuality by their standard repetition of a pattern.

On the other hand, firstly, they do not lend themselves to departures from the standard of comfort and amenity. Luxury trains or exceptions to the standard seating in the standard trains are generally expensive to fit into an interval or eventime service.

secondly, they do not lend themselves to coping with peak traffics (such as arrive off ships) without breaking the interval pattern by supplementing.

thirdly, they do not lend themselves to the principle of picking up a train load of people and conveying them to their destination without a stop.

It is a principle not lightly to be set aside to pick up a train load of people at the point of origin and convey them over a long distance without an intermediate stop. The fastest trains quoted in this report, the Goteborgaren and Stöckholmaran from Stockholm to Gothenburg, 456 km. at 101.3 km.p.h., make one intermediate stop only. The British Caledonian, 656 km. at 97 km.p.h. does the same. In the northbound service from London (King's Cross) out of twenty-one trains to Newcastle and beyond two make no stop before Edinburgh (633 km.), three more no stop before Newcastle (430 km.), and two more no stop before Darlington (370 km.).

In these last two respects the disadvantages are in an interval service only and do not apply to the eventime service.

fourthly, they are difficult to alter, and indeed if the service is closely knit, impossible to alter to meet a particular public

demand. To alter anything means altering everything. Some opinion would consider this an advantage in as much as unreasonable individual demands can be more easily set aside in the general interest.

32. No instance of a precise interval timetable has been reported, but many of eventime departures, especially in Britain. Generally it appears that in Main Line services an interval of not longer than an hour is desirable as an aide-memoire for the public. In local services where the tolerance of the public to waiting is less than on the Main Line, an interval of half-an-hour is the longest that is acceptable.

33. The experience with the King's Cross service over the past twelve years has precisely demonstrated that truth of Mr. Wheatcroft's statement quoted in Section 25 about increasing frequency leading to increased traffic, leading in turn to longer trains up to the point where they must be divided. This division has been used to accelerate the service by lengthening the stages without a stop.

34. Structure of intermediate stops.

The best illustration of the intermediate structure of two services is by comparison of the Japanese express timetable between Tokyo and Osaka and the British between King's Cross and Edinburgh. The departure times, distances and intermediate stops are set out in Appendix « C ».

The overall comparisons are set out in Table IV.

The contrast here is one of principle. The populations served by the two services are not very unlike. The terminals are very large towns and there is a need for the service to be projected beyond them to other large centres of population. Intermediately in both cases there are several places of importance. But the treatment is very different.

Japan stops nearly all her expresses, including the night trains, at nearly all the important towns on the way, thereby giving between fourteen and eighteen services a day between each point. Britain gives between two and nine only and has to achieve an adequate service between intermediate stations by running a parallel service from London to another terminal — in this case Leeds. Even so, this structure requires many passengers to change out of feeder services at an intermediate point.

On the other hand, the British method permits even with steam traction a high speed, 94.5 km.p.h. with the Limited and 86.9 km.p.h. with the ordinary expresses, speeds which would be markedly higher if the line were not being prepared for electrification.

TABLE IV.

	Japanese	*British*
Distance (km)	533	633
Traction	electric	steam
Maxim. permitted speed km.p.h.	110	140
Trains per day . . .	9	12
Trains per night . . .	10	9
Total	19	21
Train km per day . . .	10 101	11 466
Stops - number . . .	283	93
Km per stop	36	122
Overall speed :		
Limited-km.p.h. . .	69.5	94.5
Express-km.p.h. . .	54.3	86.9

35. Summary of opinion on structure. Main line.

On the evidence so far, opinion is heavily on the side of Main Line timetables with trains arranged singly or in groups tailored to the demand. Continuous services, spread throughout the

day, are confined to Egypt and Britain with Japan as a case on the fringe. Eventime departure services exist in Britain only: Interval services in a small part only of Britain and then only if one regards trains running 80 to 100 kilometres as a Main Line service.

36. The suburban need.

In suburban services the predominant demand is between 6.00 and 23.00 from workers, business men, students and school children in the morning and evening, before and after their work: from housewives and pleasure seekers during the middle of the day, from people going in search of entertainment in the evenings. Outside these hours there is in many places a small demand from workers on shift work.

37. Hours of service.

Appendix « D » summarises the basic information submitted by the seven administrations which selected a suburban service for study. In each case the hours between which the service is run are longer than the main line services in the same country. In most cases the gap in the service is as short as two or three hours in the dead of night.

38. The peak demand.

The particular characteristic of the suburban demand is its rigidity. Unlike the main line traveller the commuter will travel within a very few minutes of his set time in the acutest discomfort rather than catch a confortable earlier train or delay his departure home. Since broadly the hours of starting work in factories, offices, schools, do not vary greatly the result is a very intense demand in opposite directions twice a day.

39. The administrations do what they can to cope with this situation which is continually on the point of getting out of hand, as shown from the British report: « Compared with 1939 the daily total of passengers travelling has increased by 7.7 per cent, largely due to the greater number of people in employment as the increase in the peak periods is 15 per cent whereas in the remainder of the 24 hours there is a decrease of 4 per cent ». Britain has found in the course of converting the suburban lines in North-East London to electric traction that the most significant effect is to heighten and sharpen the peak. Improvements in service are being planned in Sweden, replacing locomotive-hauled trains by close-coupled electric motor coaches... with a maximum speed of 100 km. an hour. Egypt : « Future proposals will be increasing the period of the five minutes (frequency) service and using multiple units ». Britain (North-West London) : « four tracking of the line... extension of electrification... replacement of all rolling stock » leading to an increase in frequency of over forty per cent and in speed of twenty-five per cent. Japan reports : « At present, we are at a loss what to do to increase the speed and frequency of trains ». Since she runs on the Chuo Line thirty trains of ten cars in the peak hour other administrations will admire and sympathise.

40. Structure of suburban services.

Generally there is no general attempt at interval services in suburban timetables: and this is surprising because in this field more than any other in timetabling, a rigid pattern has great benefits for the public not only as an aide-memoire but as a help to punctuality.

41. Generally also in suburban timetables more than any other there is a clear advantage in a structure which allows the furthest possible distance to be covered without a stop. The reporter feels that in Britain at least some suburban timetables are not as intelligent as they might be owing to their oversight of the advantages of this principle to the

traveller in a faster journey time and to the administration in line occupation and use of rolling stock. This point will be developed a little further in Section 55.

42. Generally — and rightly in the reporter's view — owing to the frequency of the service the administrations do not time their suburban services in connection with main line trains or other suburban services.

43. **Publicity of services.**

There remains under the head of Convenience a brief note to be written on its presentation to the public. There should be a separate study in the format and distribution of timetables, publicity by press, poster, or leaflet, enquiry offices, the employment of agencies, the use of broadcasting systems and the like. If it is seriously advanced — as it is — that one of the principal advantages of interval services is that the traveller can readily memorise the timetable, it would be at least some progress toward satisfying his need in this respect if the timetable were readily understandable. It is a tenable conclusion that in the era of television, sound radio, the newspaper headline and the strip cartoon, a timetable which requires an intelligent approach to cross-references, to notes on other pages, and to a complex system of symbols will no longer serve.

44. **Seasonal needs.**

The demand for seasonal transport should also be a separate study, for it is a complex and intractable problem in many countries. In dealing with it railways appear at once at their best in being able to provide a tremendous over-load capacity — often not counting the cost: and at their worst in demonstrating to their public, at the time when more of them travel than at any other, their worst rolling stock, their worst overcrowding, their worst punctuality, and sometimes, by pressure of events, their worst manners.

45. The demand varies from the comfortable to the burdensome. Burma, Malaya and East Africa require only to strengthen their main line expresses. New Zealand duplicates on some occasions. Norway, Sweden and Ireland book a few extra expresses in their summer timetables throughout the week: Egypt does the same at the beginning and end of the month and on Thursdays throughout the year. India, Ceylon, Japan and Britain have very sharp and high seasonal peaks. India an increase from 20 000 to 35 000 passengers a day on her Madras — Bangalore line. Ceylon 50 000 on her system — more than double the normal traffic. Japan as shown in Table V. Britain up to nearly seven hundred per cent in her service between London and Paris. Six trains in the winter with 787 people become twenty-six in the summer peak with nine thousand. To some seaside resorts in Britain with a winter demand of a few hundreds, up to seventy thousand people demand transport by rail on a summer day.

46. It is true of Britain's locomotive-hauled main line carriages that half of them are required for use on no more than twenty days in the year.

47. **Structure of seasonal services.**

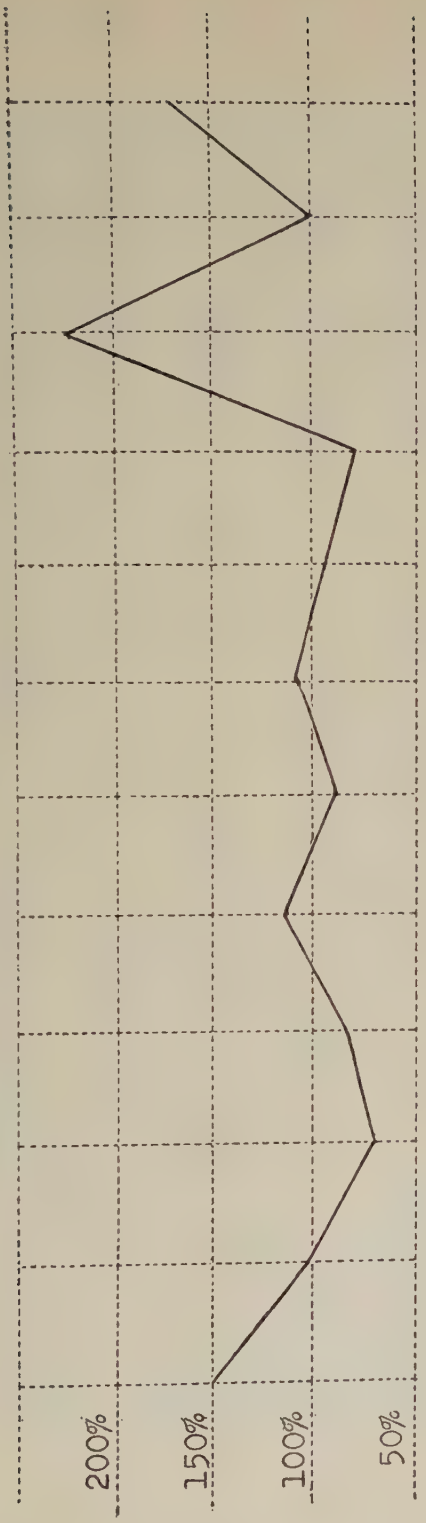
The broad divisions of the seasonal demand and the way in which they are handled are :—

a) Tourism and Annual holidays. — In the originating countries by a large increase in the published service for the days on which the holiday begins. For instance in the British service from London to the West of England there are nine trains on a winter weekday, ten on a summer weekday, eighteen booked on a summer Saturday and twenty-eight on the peak summer Saturday.

— In the receiving countries by an increase in the published service throughout the week during the tourist season. Sweden increases her service between

TABLE V.

Variations in passenger load ratios on express trains on Tokaido main line — Japan.



Stockholm and Boden from two trains to five — the peak days, not heavily peaked, are Monday and Friday. Norway requires one extra daily and one three days a week between Oslo and Bergen. Ireland has three trains extra to her normal eight daily between Dublin and Cork and doubles or nearly doubles her service to Limerick, Sligo and Tralee.

b) *Public holidays or festivals.* — This demand is very heavily peaked. Travel is either for two or more days and largely main-line, or is local and for the day. Generally administrations have the problem four or five times a year and publish special programmes for the days concerned rather than attempt to include the alterations in the published timetables. To some extent Britain uses special programmes to cope with the demand for longer holidays in the Midlands and the North, where whole towns shut down for their annual holiday at once.

c) *Trips by the day.* — This demand arises partly from special attractions such as football or horse-racing, partly from organised parties from factories, offices and so on; and partly from people using their leisure for travel. Except for the first of these three the problem presents no great difficulty.

48. **Comment on structure of seasonal services.**

In this necessarily brief survey it is possible to draw some conclusions.

I. It is to the advantage of everyone to spread the peak demand. In those countries where Saturday is now a day of leisure it is possible to induce a fair proportion to travel on Friday evening and during Friday night. In the British service to the West of England previously quoted, five of the eighteen trains leave between 12.35 Friday and 0.35 Saturday. Britain has also had some small success with inducing people to travel in the middle of the week by reducing fares on

Tuesdays, Wednesdays and Thursdays. Demand for organised parties from factories, offices and so on can be channelled to dates and in directions very much as the railway administration wishes, — as can that from people using their leisure for day trips. It is to the public's advantage in terms of cheaper fares, less overcrowding, better punctuality and to the administration's advantage in lower costs that this policy should be vigorously pursued.

II. It is preferable to publish in the regular timetables as many of the extra seasonal trains as possible even though they may run on only a few days in the year.

III. In seasonal traffics more than in any other sphere of railway operation it is possible to concentrate people in train loads at the point of origin and to run them non-stop to destination. Quite apart from the evident advantages to the passengers it is nonsense for railways on the days of peak demand for rolling stock and line occupation not to take a step which increases the capacity of both. There are at peak times far too many trains stopping at far too many stations all over the world.

IV. There is a sharp distinction between the method of adding to timetables seasonal trains running as reliefs to the booked service, such as the Swedish triplication of their 8.55 from Stockholm to Gothenburg with trains at 9.05 and 9.45, and the system of a service spread throughout the day such as the British between Liverpool Street and Clacton where the winter timetable, 8.36, 10.36, 13.36, 15.36, and so on, becomes a train every hour at 36 minutes past the hour. For services which have not the complications of large numbers of people demanding transport perforce at any time by reason of international connections and so on, there are clear advantages in the latter method.

V. As a matter of long term policy the example of Brighton commends itself. Brighton has been developed as a dormitory for London by a frequent, fast service for commuters. It is also a seaside resort. The result is that the traffic balances to a remarkable degree. On weekdays from Monday to Friday ninety-five trains are booked each way. On Saturdays the number is reduced to eighty-three in the winter and no more than ninety-two are required on the peak summer Saturday.

STUDY OF THE FIVE PRINCIPLES : II. SPEED.

49. Speed is by hypothesis a good thing, inasmuch as it reduces the time of the passenger's journey but it must not conflict at all with Safety nor unreasonably with Comfort. Within the over-riding limits of Safety and Comfort, Speed is an end in itself — not maximum speed but overall speed.

The limits on speed are partly topographical and outside the control of a railway, partly physical and under control at a high cost in money and time; partly social and partly administrative. Under the first head come mountain ranges, large rivers, marshes, and large towns, which impose permanent limits on gradient, curvature, and foundations, and so govern the speed permitted by the engineer. Under the second are the strength of the track, the lay-out of the signalling and the type and capacity of the motive power. Under the third are the needs of the population for stops at towns intermediate in a journey. Under the last is the habit of almost every administration, reasonably enough in some contexts, to extend the journey time of their passenger trains by using them to convey mails, parcels, goods, horses, cattle and the like : and indeed the need of some administrations to decelerate passenger trains in order to expedite their freight trains.

50. General approach to speed. — Main line.

Generally the administrations have not mentioned the social aspects of speed. Indeed most of them have been reserved on the subject. Some have treated acceleration as a by-product of other things. « Electrification has resulted in some reduction of the journey times... The basic motive for electrification was, however, the much lower operating costs involved as well as the possibility of being able to carry a much greater weight of coaches per locomotive unit ». From another: « The change to electric and diesel traction was a matter of economy... advantages in operation as well as in maintenance ». A third states a policy of acceleration but mentions as reasons for the policy only increased capacity of the line and frequency.

51. On the other hand, in Britain more than one recent change in a steam timetable has been with the declared object of « reducing the journey time ». The most significant contribution however is from Japan: « In 1934 the Tokyo-Numazu line was electrified. Since then the timetable has been revised on more than ten occasions in parallel with the extension of electrification and at the same time with the purpose of speeding up the trains... In 1956 the Tokyo-Osaka-Kobe electrification was completed and the time of expresses was curtailed by thirty minutes... future researches (for light weight stock) are to cut down the time of the limited expresses on the Tokyo-Osaka line from 7.5 hours to 6 hours (92 km.p.h.) ».

52. One administration posed in an intentionally negative spirit the question: « Can a shorter journey time... be thought to increase the demand for travel to any noticeable degree? ». Here is the nub of the matter. If it does not, the social need for speed is not apparent. Nor is it usually possible to distinguish the effect of an increase in speed on the volume of travel from the other improvements which normally accompany it in convenience, frequency and comfort. It is, however, demonstrably true that for travel between any two places the faster service is more attractive between those places than the slower unless the convenience of the slower in other respects is vastly (the adverb is intentional) superior.

53. In Britain the question of speed is of great importance at the present time. The declared policy of the administration is to raise the overall speed of the express service on the principal main lines to 120 km per hour and on secondary main lines to almost 100 km.p.h. with maximum speeds of the order of 160-180 km.p.h. over long stretches. Of the ancillary advantages in economy of rolling stock and manpower, and in increased capacity of the line they are well aware but the policy would never have been undertaken if there had not been a clear expectation of a significant improvement in the number of passengers in response to the shorter time of their journeys: in other words, the satisfaction of a social or economic need.

54. Table VI shows the most recent order of speed for the services quoted by the administrations, with a comparison with pre-war. This table should be read with every reservation as to circumstances of topography and equipment.

The conclusion from the replies of the administrations except the Japanese and British that policy has no regard to speed as a satisfaction of a social and economic need is advanced by your reporter, also with every reservation, in face of the very marked advances set down.

55. Speed. — Suburban structure.

In Suburban services speed is of even greater importance, as the principal factor which can mitigate the overcrowding in the peak hours and the general tedium

TABLE VI. — **Average speeds from origin to destination**
Express trains.

Km.p.h.	(1) *Group service*	(2) *Fastest train*	(3) *Notional comparison of Col.* (1) *with pre-war* (100)	
Over 100		*Sweden* *Britain*		
90 — 99	*Sweden* /o		*Sweden* /o	133
80 — 89	*Britain*	*Ireland*	*Britain*	100
	Sweden *	*Ceylon*	*Sweden* *	108
70 — 79		*Norway*		
60 — 69	*Ireland*	*South Africa*	*Ireland*	133
	Ceylon	*Japan*	*Ceylon*	160
	Japan x		*Japan* x	109
50 — 59	*Norway*		*Norway*	125
	South Africa		*South Africa*	103
	Japan Q		*Japan* Q	111
40 — 49	*Malaya*	*Malaya*	*Malaya*	100
	India		*New Zealand*	108
	New Zealand		*India*	100
Under 40	*Burma*		*Burma*	100

Not quoted : *Egypt*.

Q = ordinary expresses. — x = limited expresses. — /o = multiple unit expresses - none pre-war, notional comparison is with loco-hauled. — * = loco-hauled trains.

or anxiety of the daily journey. Appendix « D » shows a variation between 21 and 52 km.p.h. for the services illustrated. Generally it is true that with short distances between stations the overall speed of trains is bound to be low, whatever the form of traction. The only method of ensuring the suburban passenger a fast service is by eliminating as many stops as possible on his way or in other words either omitting calls at certain stations or by grouping adjacent stations in train loads of people.

As an illustration of this, the suburban electric line in London from Liverpool Street and Stratford to Shenfield (32 kms) has a peak timetable projected with stops as follows :—

	(1)	(2)	(3)	(4)	(5)
Liverpool Street	X	X	X	X	X
Stratford	—	—	X	X	X
Maryland	—	—	—	—	X
Forest Gate	—	—	—	—	X
Manor Park	—	—	—	—	X
Ilford	—	—	—	X	X
Seven Kings	—	—	X	—	X
Goodmayes	—	—	X	—	X
Chadwell Heath	—	—	X	—	X
Romford	—	X	—	—	X
Gidea Park	—	X	—	—	X
Harold Wood	X	—	—	—	X
Brentwood	X	—	—	—	X
Shenfield	X	—	—	—	X
Overall speed (km.p.h.)	63	66	48	52	40

This service will repeat itself five times in the hour. The average loading of trains (1)-(4) from Liverpool Street or Stratford will be of the order of 1 250 people and if we exclude the train which serves all stations for the benefit of passengers wishing to travel from one intermediate station to another, the speeds are exemplary.

STUDY OF THE FIVE PRINCIPLES : III. RELIABILITY.

56. There is one note of caution which must be sounded about what has been written on the subject of the structure of the service and speed. Reliability is largely a matter of day to day operation and only relevant to the rational and efficient organisation of train services, inasmuch as timetables may demand in frequency and speed more than the equipment can reliably carry out.

Mark that it is only when the equipment is under pressure that there is any conflict and in Britain at least the most frequent services and the fastest services are among the most punctual; but to achieve this result the greatest care has been taken to operate them with motive power, signalling, track lay-out, platforms which have a reserve of capacity and stringent supervision.

57. Previously this report has said that time spent in railway travel is a waste of time. It has implied that the shorter the time the greater the social benefit, and therefore that speed is a social need. The same argument, if with less force, applies to frequency if a journey is taken as a whole from door to door. Now in the higher ranges of speed and frequency there appears a conflict with reliability.

The social need for reliability is in two principal parts. The first that its converse, unreliability, is a time waster. To arrive late or to have to catch an earlier train for fear of arriving late is directly to increase unproductive time. The second that the fear of arriving late and the irritation at delays on the journey are probably the largest single component of fatigue in travel.

58. This has been a digression on which no evidence was asked from the administrations. Your reporter therefore expresses a personal opinion that in the extreme ranges where frequency and speed conflict with reliability the most important principle is reliability. A timetable must not promise more than its operators can reliably perform.

STUDY OF THE FIVE PRINCIPLES : IV. COMFORT.

59. The objects of making the passenger comfortable in a train are firstly to enable him to arrive at his destination fit to achieve what he has set out to do, and secondly, to minimise the unproductive time inherent in his journey by allowing him, if he so wishes, to occupy himself usefully on the way.

60. Cost of comfort.

It is evident that railway administrations are alive to the social need of comfort. Whether as an adjunct to a programme of changing traction or no, they report significant progress. The cost of the improvements can be heavy, not only in the direct cost of fitting such things as cushioned seats in carriages which were previously « hard », or air conditioning, but in the indirect cost of increasing legroom, introducing reclining seats, running refreshment cars, sleeping cars and the like which necessitate running additional trains. This apparent economic disadvantage may prove in fact to be a benefit to the administration if it more than covers the extra cost by attracting enough traffic, or to be a national advantage by reducing the national bill for ill-health.

61. Principles of comfort.

To be comfortable, a passenger requires to be in a position of ease to do what he may be doing, to be in a reasonable temperature in clean and dry surroundings, to be free from unreasonable noise and jolting, and to have access, if his journey is a long one, to lavatories and meals.

Generally a passenger is regarded by the administrations as at ease, if seated when awake, and if lying or reclining when asleep. Certainly almost all administrations have reported a degree of standing, especially in suburban travel but three only have appeared to tolerate it and those three for journeys up to one hour. The remainder suffer from a traffic problem which has outrun their resources.

62. Suburban overcrowding.

In suburban travel to the largest towns the cost of providing every passenger with a seat during the peak hours is prohibitive and the efforts to overcome the difficulty by spreading the peak have been uniformly unsuccessful. The Long Island Railroad attempted to change the hours of New York offices — no result. In India, « staggering the working hours of commercial offices was tried in the past with no result ». Egypt : « We failed to spread the peak traffic over a long period ». Japan : « We have once tried a staggered commutation system... but the project has ended in vain ». Table VII shows the extent of their overcrowding.

In Sweden and Britain there have been long-standing committees on the problem. London has succeeded in making some small changes in the hours of offices, but the general effect has been negligible.

63. The problem is chronic in the largest towns. And in fact, the effect in London of a significant improvement in suburban service by a change of traction has been to intensify the high peaks and in a short time to render the problem more acute than ever.

And yet overcrowding which leads to passengers standing is medically unsound : « when a person, especially a young person stands for any length of time there is a pooling or collecting of blood in the legs. Having adopted an erect posture we have done so at the risk of overstraining the control valves in our veins... To counteract the effect of standing blood is drained from our skin and intestine... this slows down digestion... Seating should be thought of, not merely as an added comfort but as an essential for journeys to work early in the day and back again in the evenings ». Thus an authoritative British medical opinion.

64. Seating.

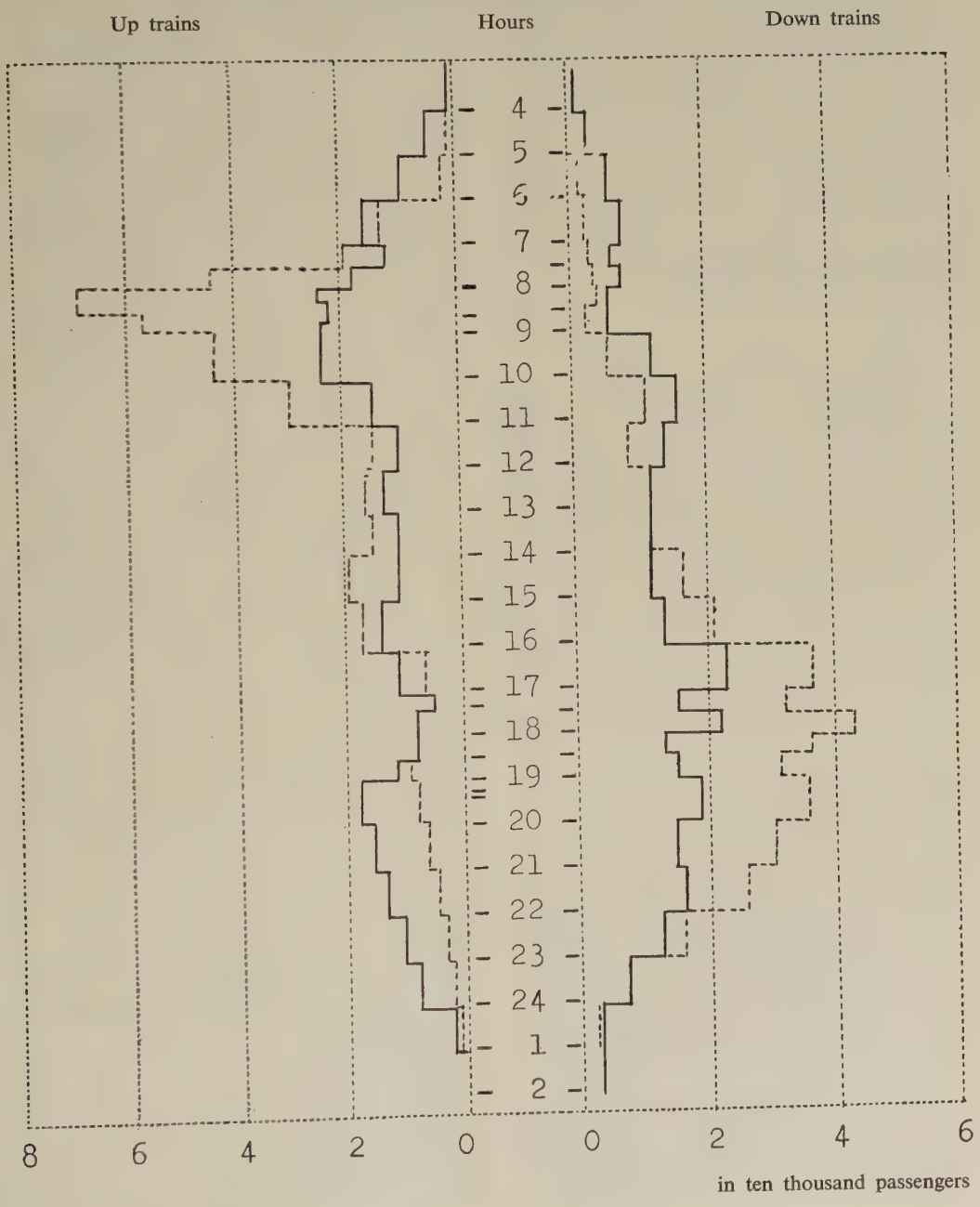
For longer distances by day, all administrations which had them are moving away from hard to padded or cushioned seats. Several are introducing adjustable reclining seats; New Zealand for journeys over an hour, Norway, Sweden, Burma; Britain has prototypes in service; Japan between the war and 1955 has introduced 177 such vehicles in first and second class. Such a design if it preserves the usual seating, back to back in coupé form, reduces the capacity of the vehicle very seriously. If, however, the design arranges the seating in blocks facing the same way, the loss of seats is not a great matter.

Apart from this advance there is a good deal of research going on into the most suitable design of normal seat in respect of height from the floor, angle of seat and back, position and width of armrests, if any, height and depth of headrests.

65. Sleeping.

At night, all the administrations which operate over long distances provide sleeping cars. A journey of eight hours is the generally accepted minimum for this amenity. Sweden, however writes : « The night journey time should preferably be

TABLE VII.


Up trains
Hours
Down trains
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
1
2
8
6
4
2
0
0
2
4
6
in ten thousand passengers
——— : Capacity
- - - - - : Number of passengers

not less than eight hours. The actual travelling time, however, can be shortened if the passenger can be granted access to his sleeping car in good time before the train departs or can be permitted to remain in the sleeping car after the train has arrived ». A few sleeping car runs in Britain also are less than six hours.

Most administrations provide sleeping cars in two classes. The standard of comfort varies from a mere place to lie down with no bedding to a high-class single bedroom with bathroom.

66. Ventilation and heating.

The next requirement, that of reasonable temperature, depends to some extent on the climate. The administrations who have replied range from the tropical through the temperate to the arctic, and the variations are reflected in the equipment. It seems that the traditions of conventional design are in this respect dying hard. Windows which open, roof ventilators, heating by piped steam or electric tubular heaters below the seats are still the rule in even modern rolling stock. The tropical countries supplement ventilation by fans. India, in fact, is installing fans in old as well as new third class stock.

Insulation against heat and cold as a specific project seems to have made little headway. India is building third class stock with double casing roof and there are British prototypes with double windows. Of the two solutions, pressure ventilation with insulation and air conditioning — the reporter abandons windows which open as unsuitable in any climate — most administrations prefer air conditioning. Progress in this respect has been made in Burma, Egypt, India, Malaya, all tropical countries; in Norway in the far north and in Japan in the temperate zone. The vehicles fitted are in the main sleeping cars, dining cars and the like. Japan has all dining cars, sleeping cars and observation cars air-conditioned in her Limited Expresses and will soon have covered all ordinary Express trains on principal routes. In Suburban travel the Long Island Railroad is partly equipped with air-conditioned rolling stock.

Apart from Long Island and to a lesser extent Japan, the approach to the problem of temperature appears to be tentative. Air conditioning is certainly extremely costly, and pressure ventilation combined with insulation of the vehicle may prove to be a satisfactory and cheaper alternative. If research is needed, it should be pressed forwards for the problem of temperature has not been solved yet in a way which meets this reasonable and elementary need.

67. Cleanliness.

On cleanliness little need be said, except that it is a prime social need. Standards vary very widely between administrations and from place to place within the territory of some administrations. Little new knowledge is necessary, but much equipment and training of railway staff and of the travelling public.

68. Noise.

Freedom from unreasonable noise and jolting raises firstly the problem of the track — design and maintenance. Generally administrations limit speed at the level of comfort rather than safety : Sweden for instance limits sleeping car trains to 100 km. an hour « to avoid undue shaking » and many other quotations of the same kind appear in the reports. More than one administration will raise the permitted speeds when a programme of relaying track and re-aligning curves is complete. Burma reports : « The replacement of 60 lb. rails by 75 lb. rails will also contribute to the comfort of passengers, while the added speed of the proposed diesel trains will considerably reduce the journey time ». Note the order — comfort before speed. To this

end, design of the rolling stock also contributes — often conveniently with insulation against noise as a by-product of pressure ventilation or air-conditioning.

69. It is, however, curious that while administrations generally are conscious of external conditions as affecting comfort, there has been so little progress in abolishing or drastically limiting the number of intermediate stops on sleeping car trains with their attendant brou-ha-ha of engine-changing, attaching or detaching vehicles, loading and unloading passengers, mails, parcels, goods. It is understandable in countries where on each route there may be one or at most two night trains, but in some countries night travel is very highly developed and a series of trains is timetabled calling at a series of stations, sometimes on one another's heels. Night travel is the one instance where travel is not a waste of time. It should be developed as a social benefit. To give passengers uninterrupted rest is an end in itself.

70. **Privacy.**

By day absence of noise raises different and very large problems. By night the social need, sleep, is common to all ages and conditions of man. By day man becomes an individual who demands — and to a great extent needs — to be treated as such. In the course of a walk through one train the diversity of activity, or inactivity, is notable — reading, writing, looking out of the window, smoking, sleeping, conversing, playing cards, knitting, keeping children amused, suckling a baby, eating, drinking, going to the lavatory, arguing with a Ticket Inspector. Some of these activities are less compatible with others than the rest. Those which are less compatible may be tolerable on a short journey and intolerable on a longer.

Most administrations compromise in their solutions by a combination firstly of open and compartment stock and secondly of two or more classes of travel. Apart from a few countries where for security compartment stock is in general use, there appears to be a strong trend toward open stock for short journeys and less strongly for long journeys. The outstanding instance is the introduction in Britain of a very large fleet of diesel multiple-unit trains built as open saloons with a clear view both forward past the driver and to the rear. In spite of the preference of the British in favour of compartments declared persistently in questionnaires over the years, these trains have proved extremely popular. In suburban travel, Sweden and Britain among others have increasingly built stock with centre gangways. For longer distances the trend is not so marked. It is generally true that the countries which have in the past settled for centre corridor stock show no sign of moving toward compartments but the approach of the previously compartment-minded countries to open stock is more tentative.

71. It is probably true that with a proper design of seat with due attention to height of the headrest and with the advent of sound-insulation and self-contained ventilation the principal objections to open stock can be overcome — except conservatism. To overcome this too, persistent education and an advance in the standard of amenity is necessary at the time of any change from compartment to open carriages. It is certainly true in Britain that on long distance trains which have a mixture of open and compartment carriages, such as the Flying Scotsman, Talisman, East Anglian and so on, the open carriages which are more attractively furnished are popular. The Pullman trains moreover which are composed entirely of open carriages attract generally full loads.

72. If this trend continues, the Swedish practice of providing specially fitted compartments for mothers and babies on all day trains on the main lines and on some night trains is worthy of note.

Generally also this comment from India for the benefit of long distance passengers is useful. « On long distance trains exclusive carriages and compartments are provided for the convenience of passengers travelling 480 kilometres or above on Broad Gauge and 320 kilometres on Metre Gauge. In this way such long distance passengers are protected from their compartments being overcrowded by relatively short distance passengers ».

73. Segregation of activity in favour of those who wish to read and write productively, that is business men, government servants and the like, but not unfortunately students, is possible by the system of two or more classes. For short distances this system is on the decrease. Burma, Sweden, New Zealand and Britain report single class travel for many suburban and secondary services. On long distance trains two classes are the rule. Ireland and Ceylon, however, report that the proportion of first class travel is decreasing seriously, Ireland by some forty per cent and Ceylon to the extent that ninety-five per cent of travel is now second class. Ceylon reports : « Development of comfort has chiefly been for the benefit of the third class passenger... who was provided prior to 1950 with wooden seats and sparse lighting. Cushioned seats, more space, fluorescent lighting, fans, have since been introduced... ». Ireland likewise : « It seems likely that the tendency for first class travel to decline is due... perhaps to an even greater degree (than competition from the private car) to the improvement in standard of second class accommodation... ». In India : « All Class III trains, called Janata trains, i.e. People's trains, have been introduced on certain long distance routes and the policy is to progressively increase the number ».

These views raise the question whether the system of two classes should be preserved not so much by a difference in the standard of comfort but by a difference in the standard of privacy — that is to say that some passengers should have access to compartment stock and pay a supplement above second class for that privilege.

74. Meals, washing, etc.

As to access to occasional amenities, lavatories and meals, Sweden writes : « In the year 1938... not only water for washing but also drinking water was available in all carriages. On day trains dining cars were included and in addition many also carried refreshment cars to supplement the service. On night trains, coffee, tea, light beers and mineral waters were served, either in the carriages or in special refreshment cars... As new passenger carriages are delivered small alterations (are) made intended to raise the standard of comfort such as... electric shavers in sleeping cars ». All administrations except New Zealand provide some service of refreshments on long distance trains. New Zealand allows time for the purpose at wayside stops. There is some trend toward a common class of dining car. In India : « Dining and restaurant cars which were only open to passengers travelling in I class and air-conditioned accommodation have now been thrown open to all classes of passengers during meal-hours ». In Britain on a number of trains on which first and second class restaurant cars used to run, a common class car is now provided.

75. There is a tendency also toward a simpler service of refreshments but more widely spread over the timetable. Ireland reports : « There is a development toward the withdrawal of full dining car facilities and substituting buffet cars with cafeteria service ». Burma is for the first time to introduce restaurant cars. India's policy is « to progressively extend the service to all long distance trains in the country ». Malaya is increasing steadily the number of Buffet cars. The principle is

equally true of Britain and other administrations.

76. Comfort. — Summary.

In brief, there are clearly great advances going forward in comfort. They are under the following main heads :—

Abolition of « hard » seating;
Design of seating — fixed and adjustable;
Lower class sleeping cars;
Ventilation and heating;
Standards of comfort generally in lower class stock;
Refreshments.

The heads under which your reporter has failed to detect general progress, where it appears advisable are :—

The design of suburban stock for the inevitable overload;
Cleanliness;
Timetabling of sleeping car trains for uninterrupted rest;

It need hardly be repeated that comfort which enables the passenger to reach his journey's end refreshed and, if he so wishes, to occupy himself productively on the way, is a prime social and economic need.

STUDY OF THE FIVE PRINCIPLES :

V. CHEAPNESS.

77. The last main principle which affects the rational and efficient organisation of timetables with the prime object of the social and economic needs of the populations served is the cheapness of the service.

Nationally the cost of passenger transport is a burden which very broadly become a matter of individual choice only for travel during hours of leisure. The remainder of the cost is a direct charge on the gross national product which for the benefit of the nation and of the individual should be as low as possible. In the light of this principle let us examine Safety, Convenience, Speed, Comfort.

78. Safety is an absolute matter with which it has been said earlier other principles must not conflict.

79. Convenience. — The principal movement costs of a passenger service are carriages, engine, crew, fuel, in that order. Several administrations have, however, no regard to the use of rolling stock in the design of their passenger service. In Main Line services the distance run per engine per day ranges from 50 to 600 kms. the latter a steam service with a single journey of less than 200 kms. : the distance per multiple unit rises to 325 kms. and for carriages to just over 300 kms. In Suburban working one service gets 260 kms. a day out of its multiple units with a journey of 32 kms.; eight times as much as the lowest figure quoted. In a recent British timetable two day journeys — London to Edinburgh and back, 1 270 kms. — were scheduled for the same set of carriages.

Several administrations with Group services show very good records. India with 360 and 294 kms. per day from two classes of Pacific engines. Burma with 246 kms., Norway with 306 kms. from electric engines and 325 kms. from multiple units. On the whole, however, in spite of the short distances to run Britain, in those parts which have paid especial attention to the use of rolling stock, has the best record. That experience shows that an eventime or interval service properly planned can be the cheapest to operate per train mile.

80. Speed. — Increases in maximum speed often require large expenditures on track and motive power and smaller expenditure on fuel. The point at which savings in carriages, engines and crews overtake the higher costs for speed is for calculation in each case. In the many cases where fuel only has to be thrown into the

scale it is the reporter's experience that higher overall speed is almost always an economy. There are very few timetables which do not become untidy from small changes as the years go by. These changes are almost always costly — extra stops, a new train introduced, a train cancelled. In any country like Britain where this process of piecemeal change goes on in response to the supposed public demand, every timetable ought to have a complete overhaul every few years. The result is invariably better service to the public at lower cost — generally as a result of higher speed.

81. Comfort. — Every increase in comfort is expensive, often very expensive. Administrations can only hope to recoup themselves by an increase in the travel habit and in its absence must reflect on their contribution to a reduction in national fatigue and ill-health. One day a study may show this reduction to be significant.

CONCLUSIONS.

82. It remains to attempt conclusions about the principles which may lead to a rational and efficient organisation of passenger train services.

83. It is the social and economic duty and interest of the administrations to provide a safe, convenient, fast, reliable, comfortable, cheap passenger service.

84. The hours of the passenger day on the Main Lines are 7.00 to 23.00 with some support for 6.00 departures for short journeys. In suburban areas from 4.00 to 1.00 with small variations on each side of either figure.

The capacity of diesel or electric traction to work virtually without intermission gives them a clear advantage over steam, especially in suburban work and in areas where engines released from passenger service can be used on freight trains.

85. For long journeys, say eight hours or over a preference for night travel is generally expressed. The latest night departure should be not later than 23.00 and the earliest arrival not earlier than 6.00. Some preferences are expressed for between 5.00 and 7.00 in arrivals.

86. Day journeys, outward and return in the same day, should not exceed six hours each way.

87. Day journeys, one way only, should leave forenoon or afternoon clear. They may be, therefore, up to six hours in the morning or eleven hours, 12.00 to 23.00 in the afternoon. There is room for development of long journeys at high speed in the afternoon and evening.

88. The importance of frequency of services is recognised in suburban timetables but not on Main Lines. Most administrations prefer the Group method on Main Lines — Egypt, Japan and Britain dissenting; the first two with some reservations; the last alone in favour of eventime or interval timetables.

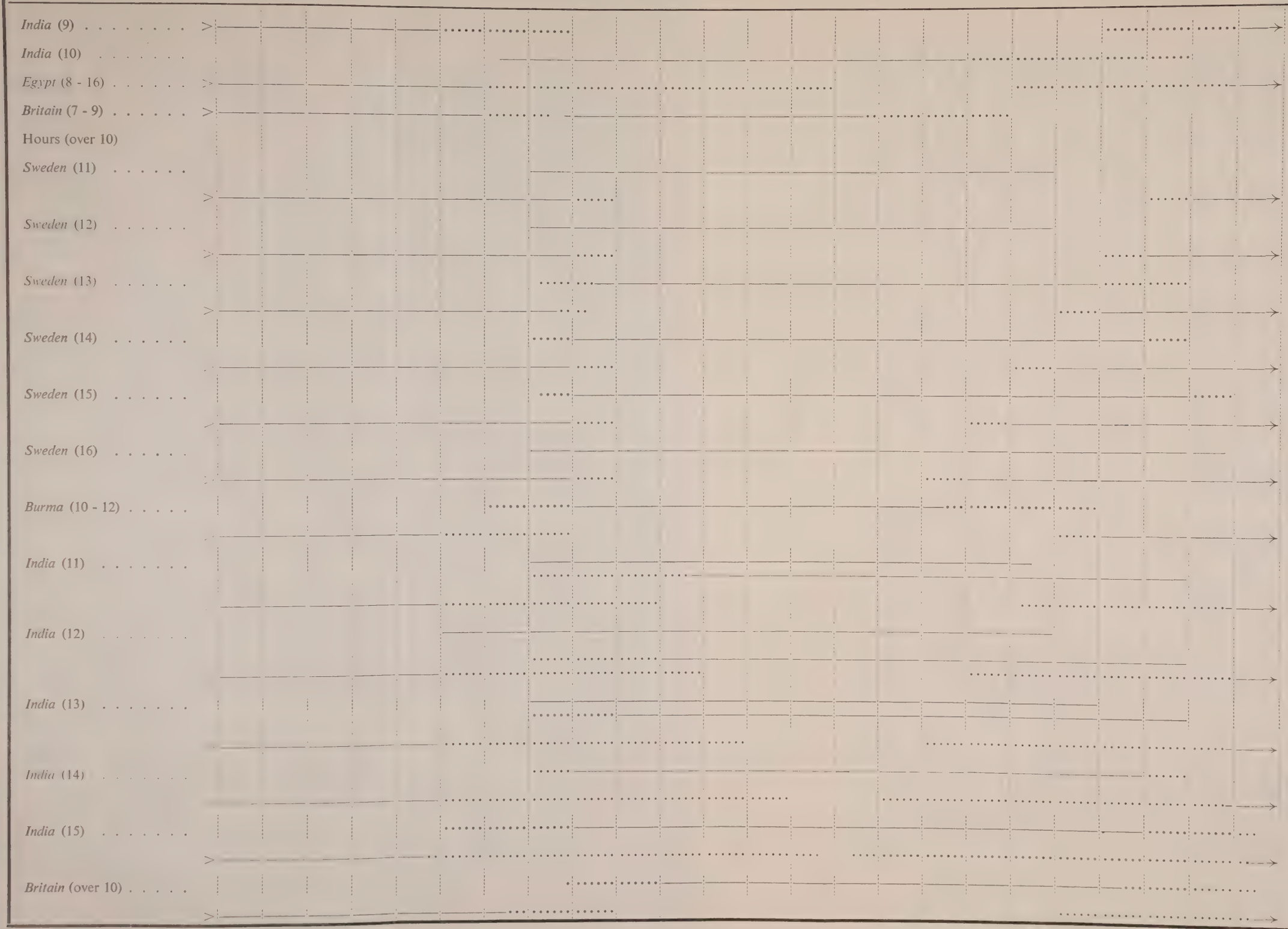
In the matter of frequency the advantages of multiple unit stock especially for suburban work in reducing the number of movements at terminals and in greater acceleration on the road gives diesel or electric traction a clear preference.

89. Few principles emerge from the comments on the structure of the timetable between terminals. Generally the Main Line expresses have intermediate stops between the terminals with the double object of satisfying the needs of the intermediate stations and of supporting economically a more frequent service between those terminals. No administration has enunciated the principle of concentrating passengers in train loads for long non-stop runs, even though the Group system, which most prefer, lends itself to this method.

OPTIMUM HOURS OF JOURNEY

Hours of day	0	1	2	3	4	5	6	7	8	9	10	11	N	13	14	15	16	17	18	19	20	21	22	23	Mdnt.	*REMARKS*
Length of journey																										Dotted lines represent alternative suggestions.
Hours (2 - 4)																										
Norway																										
Sweden (2)	>																								→	
Sweden (3)																										Outward and Return on same day.
Sweden (4)																										
Ireland (3 1/2)																										
New Zealand (2 - 5) . . .																										Ditto.
Burma (3 - 4)																										
Ceylon																										
India (2 - 4)																										
Egypt (2 - 4).	>																									
Britain (2 - 4)																										
Hours (5 - 6)																										
Norway																										
Sweden (5)																										Outward and Return.
Sweden (6)																										
Ireland (5)																										
India (5)																										
India (6)	>																								→	
Egypt (5 -6/7)																										
Britain	>																									
Hours (7 - 10)																										
Norway																										
Sweden (7 - 10)																									→	
	>																									
New Zealand																										
Burma (6 - 8)																									→	
Ceylon (over 6/7)	>																								→	
India (7)	>																								→	
India (8)	>																								→	

OPTIMUM HOURS OF JOURNEY



Hours 15 - 24 any hour between 7 and 23.00.

N. B. — Dotted lines indicate alternative hours quoted.

Diesel and electric traction lend themselves to long non-stop runs owing to their capacity to travel long distances without attention.

90. In seasonal traffics the principles seem to be :—

The importance of measures to spread the peaks;

The publication of seasonal trains in the timetables;

The need to develop two-way traffics, and, of course,

Long non-stop runs.

91. The proposition that overall speed is an end in itself commands little declared support from the administrations. Speed is more often than not regarded as a by-product of other things. Yet overall speeds have gone up significantly in most countries.

Diesel and electric traction lend themselves to speed with their capacity for rapid acceleration from terminals or intermediate stops and sustained high speeds, especially up hill over virtually indefinite distances.

92. Reliability is important as a social need. The timetable must not promise more than its operators can punctually perform.

Diesel and electric traction have a clear advantage, especially electric traction which is so often allied in practice perforce with colour light signalling and other betterments.

93. The progress in comfort is significant, especially in cushioned seating in the lower classes, reclining seats, sleeping cars for lower classes, air-conditioning and ventilation. There remain such matters as cleanliness, insulation against noise, overcrowding in suburban trains, stops on night trains, use of passenger trains for parcels, mails and freight where progress has been patchy or non-existent.

Diesel or electric traction by providing a source, if so designed, of sufficient power for transmission to the train can be the final answer to the problems of ventilation, heating, and interior cleanliness. By their very nature they solve most of the problem of exterior cleanliness. Neither diesel nor electric traction need raise any question of noise.

94. There are some marked trends toward :—

Centre corridor saloon carriages;

Local and Suburban stock of one class;

Smaller differences between upper and lower class;

Simpler refreshments in unclassed cars.

95. Movement costs can be significantly lowered by designing timetables with the use of rolling stock as a prime consideration.

Conversion to diesel or electric traction provides the opportunity and a better means than steam of changing policy in this sense.

96. The trend toward diesel and electric traction is extremely strong. Appendix « E » sets out for 1938, 1950 and 1955 the length of line on which each administration operates either method. Apart from this progress many administrations have projected programmes for the complete abandonment of steam. In fact there is going on a railway revolution of far greater scope and at a far greater pace than the revolution of George and Robert Stephenson, George Hudson the Railway King, and Isambard Kingdom Brunel.

SUMMARY
MAIN L

Country	*Line described*	*Distance* km	*Traction* D = Diesel E = Electric S = Steam	*Daily demand each way*
Norway	Oslo - Bergen	492	D & S 385 km D & E 107 km	—
	Oslo - Trondheim	553	D & S 427 km	—
	Oslo - Stavanger	599	E	—
Sweden	Stockholm - Boden	1 100	E	4 - 600
	Stockholm - Gothenburg	456	E	1 200 - 2 000
	Gothenburg - Malino C	300	E	1 300 - 2 000
Ireland	Dublin - Cork	266	D	800
	Dublin - Limerick	198	D	300
Malaya	Kuala Lumpur - Singapore	398	S[x]	—
New Zealand	Auckland - Wellington	684	S & E 40 km	—
Burma	Rangoon - Mandalay	617	S	500
South Africa	Durban - Johannesburg	795	S & E	1 200
Ceylon	Colombo - Badulla	290	D	—
East Africa	Mombasa - Nairobi	530	S	—
Japan	Tokyo - Osaka	534	E	—
India	Madras - Bangalore	355	S	(20 000)
Egypt	Cairo - Shellal	886	S & D	(48 000)
	Cairo - Alexandria	208	S & D	(39 000)
Britain	London - Birmingham (*a*)	181	S	5 000
	London - Birmingham (*b*)		S	
	London - Glasgow	644	S & D	1 500
	Glasgow - Aberdeen	245	S	—
	Glasgow - Dundee	134	S	
	London - Plymouth	363	S	1 000
	London - Paris	462	S(*c*)	800

Legend : G = group. — C = continuous. — I = interval. — E = eventime departure.
(*a*) = via Coventry. — (*b*) = via Banbury. — (*c*) = and steamship.

APPENDIX B

MATION
T SERVICES

Seasonal variation per day	Regular type	Service ø No. trains each way	Seasonal service No. extra trains		Speed overall regular service km.p.h.	Hours of service of C.I. or E.
			Regular	Peak		
Large	G	2	1	—	42 62	—
Large	G	2	1	—	49 69	—
Large	G	2	1	—	52 - 72	—
2 - 3 000	G	2	3	—	60	—
700 - 3 250	C	8	4	—	72 - 101	7.30 - 23.00
800 - 3 000	C	6	1	—	40 - 74	7.30 - 23.00
	C	8	—	—	32 - 89	6.30 - 22.00
800	G	2	2	—	61 - 66	—
—	G	2	—	—	36 - 48	—
—	G	2	—	—	35 - 40	—
700	G	1	—	—	29	—
Slight	G	3	—	—	43 - 52	—
(50 000)	G	1	—	—	24	—
—	G	2	—	—	38	—
—	C	19	—	—	40 - 70	9.00 - 23.00
(35 000)	C	8	—	—	24 - 46	6.00 - 21.00
—	G	2	—	—	40 - 63	—
Large	C	19	1	—	40 - 70	3.30 - 21.30
9 000	C	10	2	—	76	0.00 - 21.30
	C	11	—	—	65	
3 500	C	8	1	—	75	8.30 - 22.30
Large	E	6	—	14	72	7.00 - 23.00
15 000	C	7	11	21	75	9.30 - 23.50
5 000	C	6	10	26	58	9.00 - 21.00

between terminals named. — (x) = Diesel with new timetable in 1957 after report submitted.
= Figure not applicable to whole distance.

**STRUCTURE OF SERVICE BETWEEN KIN
MAIN L
WIN**

		L							
LONDON	1.00	7.50	9.00	10.00	10.10	11.50	12.30	13.00	14.0
Hitchin	—	—	—	—	—	—	—	—	—
PETERBOROUGH	—	—	—	—	X	—	—	X	X
GRANTHAM	—	—	X	—	—	—	X	—	X
Newark	—	—	—	—	—	—	—	—	—
Retford	—	—	—	—	—	—	—	—	—
Doncaster	—	—	X	—	—	—	—	—	—
Selby	—	—	—	—	—	—	—	—	—
YORK	—	—	X	—	X	—	X	X	X
Darlington	X	X	X	—	X	X	X	X	X
Durham	X	—	X	—	—	—	X	—	—
NEWCASTLE	X	X	X	X	X	X	X	X	X
Morpeth	—	—	—	—	—	—	—	—	—
ALNMOUTH	—	—	—	—	—	—	—	—	—
Berwick	—	—	—	—	X	—	—	X	—
Dunbar	—	—	—	—	—	—	—	X	—
Edinburgh	—	X	—	X	X	X	—	X	—
Stops	3	3	6	2	6	5	5	7	5
Distance to first stop	370	370	170	430	130	300	170	130	13
L = limited.									
To : —		*Perth*		*Aberdeen*	*Glasgow*	*Glasgow*		*Perth*	

APPENDIX C

AND EDINBURGH (BRITAIN)
SSES

L										
16.00	16.50	17.35	19.45	20.20	22.15	22.30	23.20	23.35	23.45	23.55
—	—	—	—	—	—	—	—	—	—	—
—	—	X	—	X	—	—	—	—	—	X
—	—	X	X	X	—	X	—	—	X	X
—	—	—	—	X	—	—	—	—	—	X
—	—	—	—	X	—	—	—	—	—	—
—	—	—	—	X	—	—	—	—	—	X
—	—	—	—	—	—	—	—	—	—	—
—	X	X	X	X	—	X	—	—	X	X
—	X	X	X	X	—	X	—	—	X	X
—	—	—	—	—	—	—	—	—	X	X
X	X	X	X	X	—	X	X	—	X	X
—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	X	—	—	—	—	—	—
—	—	—	—	X	—	X	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—
X	—	—	X	X	—	X	X	X	—	—
2	3	5	5	11	—	6	2	1	5	8
430	290	130	170	130	(730)	170	430	650	170	130
			Aberdeen		*Aberdeen*	*Aberdeen*				

STRUCTURE OF SERVICE BETW

MAIN L

	L					L	
TOKYO	9.00	9.30	10.00	10.30	11.00	12.30	13.
Shinagawa	—	X	X	X	X	—	X
YOKOHAMA	X	X	X	X	X	X	X
Ofuna	—	X	X	X	X	—	X
Odawara	—	X	X	X	X	—	X
Yugawara	—	X	—	—	—	—	—
Atami	—	X	X	X	X	X	X
Mishima	—	X	—	—	—	—	—
Numazu	X	X	X	X	X	—	X
Fuji	—	X	—	—	—	—	—
Shimizu	—	X	X	X	—	—	—
SHIZUOKA	—	X	X	X	X	X	X
Hamamatzu	X	X	X	X	X	—	X
Toyohashi	—	X	X	X	X	X	X
Gamagon	—	—	—	X	X	—	—
Okazaki	—	X	—	—	—	—	X
Kariya	—	X	—	—	—	—	—
Obu	—	—	—	—	—	—	—
Atzuta	—	X	—	—	—	—	—
NAGOYA	X	X	X	X	X	X	X
Owari	—	X	X	X	X	—	X
Gifu	X	X	X	X	X	—	X
Ogaki	—	X	X	X	X	—	X
Maibara	—	X	X	X	X	—	X
Hikono	—	X	—	—	—	—	—
Otzu	—	X	X	X	X	—	X
KYOTO	X	X	X	X	X	X	X
OSAKA	X	X	X	X	X	X	X
Stops	7	25	18	19	18	7	18

L = limited.

To : — *Kumamoto* *Moji* *Kagoshima* *Kagoshima*

APPENDIX C *(continued)*

O AND OSAKA (JAPAN)

ESSES

	L										
	18.30	20.00	20.30	20.45	21.00	21.15	21.30	21.45	22.15	22.30	23.00
	—	X	X	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X	X	X	X
	—	X	X	X	X	X	X	X	X	X	X
	—	X	X	X	X	X	X	X	X	X	X
	—	—	—	—	—	—	—	—	—	—	—
	X	X	X	X	X	X	X	X	X	X	X
	—	—	—	—	—	—	—	—	—	—	—
	—	X	X	X	X	X	X	X	X	X	X
	—	X	—	—	—	—	—	—	—	—	—
	—	X	—	—	—	—	—	—	—	—	—
	X	X	X	X	X	X	X	X	X	X	X
	—	X	X	X	X	X	X	X	X	X	X
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	X
	—	—	—	—	—	—	—	—	—	—	X
	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	X
	X	X	X	X	X	X	X	X	X	X	X
	—	—	—	—	—	X	—	X	—	↓	↓
	—	X	X	X	X	X	X	X	X	—	—
	—	X	—	—	—	X	—	—	X	—	—
	—	X	X	X	X	X	X	X	X	—	—
	—	—	—	—	—	X	—	—	—	—	—
	—	X	X	—	X	X	X	—	X	—	—
	X	X	X	X	X	X	X	X	X	—	—
	X	X	X	X	X	X	X	X	X	—	—
	6	18	14	13	14	18	14	14	15	10	13
	Hakata		*Hakata*	*Hiroshima*	*Kobe*	*Kobe*		*Kagoshima*	*Hiroshima*	*Minatomachi*	*Toba*

APPENDIX C *(Contd.)*

Number of services between intermediate stations.

BRITAIN	*Grantham*	*Doncaster*	*York*	*Darlington*	*Newcastle*	*Edinburgh*
Peterborough	ø	ø	ø	6	6	3
Grantham	—	ø	ø	9	9	3
Doncaster	—	—	ø	3	3	2
York	—	—	—	ø	ø	5
Darlington	—	—	—	—	ø	ø
Newcastle	—	—	—	—	—	ø

ø Other Express services between London and Leeds, or Leeds and Edinburgh supplement the King's Cross service.

JAPAN	*Odawara*	*Atami*	*Numazu*	*Shizuoka*	*Hamamatzu*	*Nagoya*	*Gifu*	*Maibara*	*Kyoto*	*Osaka*
Yokohama	16	18	17	18	17	19	15	14	17	17
Odawara	—	16	16	16	16	16	14	14	14	14
Atami	—	—	16	18	16	18	14	14	16	16
Numazu	—	—	—	18	17	17	15	14	15	15
Shizuoka	—	—	—	—	16	18	14	14	16	16
Hamamatzu	—	—	—	—	—	17	15	14	15	15
Nagoya	—	—	—	—	—	—	15	14	17	17
Gifu	—	—	—	—	—	—	—	14	15	15
Maibara	—	—	—	—	—	—	—	—	14	14
Kyoto	—	—	—	—	—	—	—	—	—	17

SUMMARY	**Winter service** *East Coast*	**Spring service** *Osaka*
Traction	Steam	Electric
Number of trains : Day	12	9
Night	9	10
Total	21	19
Maximum permitted speed km.p.h.	140	110
Overall speed of service km.p.h. : L	94.5	69.5
Express	86.9	54.3
Km run per stop	122	36
No. train km per day	11 466	10 101
No. of stops	93	282

SUBURBAN SERVICES

Country or Railway	*Line described*	*Traction*	*Daily passengers number*	*Hours of service*		*Hours of peak service*		*Frequency (trains per hour)*		*Overall speed* (km)
				Actual	*Total*	*Morning*	*Evening*	*Off peak*	*Peak (max.)*	
Long Island . .	Environs of New York (East)	electric	285 000	continuous	24	N.Q.	N.Q.	N.Q.	N.Q.	40
Burma	Environs of Rangoon	steam	30 000	5.00 - 20.00	15	6.30 - 9.30	15.00 - 18.00	4	10	21
Egypt	Bab-el Luk -Hallwan	electric	53 000	4.30 - 2.00	21½	6.30 - 8.00	14.00 - 17.00	6	12	35
India	Environs of Bombay (VT)	electric	450 000	3.40 - 0.40	21	9.00 - 11.00	17.00 - 19.00	9 - 11	24	35
Japan	Tokyo (Chuo Line)	electric		3.00 - 1.00	22	7.00 - 11.00	16.00 - 22.00	12	30	30
Sweden . . .	Environs of Stockholm	electric	42 000	4.00 - 1.00	21	7.45 - 8.45	16.45 - 17.45	1 - 4	15	40 - 44
Britain	Environs of London (South)	electric	790 000	continuous	24	7.00 - 10.00	16.00 - 20.00	up to 6	20	43 - 52

Not suitable : *Norway, New Zealand, Ireland, Ceylon, Malaya, South Africa, East Africa.* — N.Q. = not quoted.

Progress in electrification and dieselisation : line worked by diesel or electric traction (km).

Country	*Route km of line*	1938		1950		1955		*Per cent Diesel & Electric*	*Future*
		Diesel	*Electric*	*Diesel*	*Electric*	*Diesel*	*Electric*		
India	55 000	—	378	—	378	310	378	1.25	Large programme of diesel and electric projected.
Burma	2 950	—	—	—	—	—	—	—	Programme of main line, local and suburban diesels.
Ceylon	1 417	—	—	1 417 ø	—	1 417 ø	—	100 ø	64 km to be electrified, remainder to be diesel.
Malaya	1 583	—	—	—	—	—	—	—	Diesels introduced 1957.
South Africa . . .	22 848	—	124	—	857	—	1 134	4.96	Programme of diesels.
New Zealand . .	4 380	—	75	—	75	—	98	2.24	Experimental programme of diesels.
Norway	4 328	—	336	—	1 029	—	1 229	28.29	1 200 km to be electrified, remainder to be diesel.
Sweden	15 812	2 386	3 719	6 319	6 218	8 261	6 346	92.38	Conversion almost complete.
Japan	19 705	1 938	611	1 527	1 662	6 634	1 961	43.62	Large programme electric and diesel.
Egypt	4 350	130	—	155	—	200	25	5.17	Diesel programme.
Long Island . . .	860	N.Q.	N.Q.	N.Q.	N.Q.	420	170	68.64	Figures as quoted.
Britain	30 000	—	3 750	—	3 830	—	4 170	13.9	Conversion to electric and diesel in progress.
Ireland	3 032	—	—	—	—	1 803	—	59.46	Conversion to diesel virtually complete 1957.

ø = part steam, part diesel. — N.Q. = not quoted.

[625 .285]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

17th. SESSION (MADRID, 1958).

QUESTION 3.

Design and improvement of railcars and multiple-unit diesel trains, as regards :

— traction power equipment (location and suspension of the engine, type of transmission);

— characteristics of the construction (body and bogies); weight reduction;

— sound-proofing, heating, ventilation, air conditioning (supply of power required, advantages and drawbacks); buffer and traction gear. Intercommunication.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, Ceylon, Egypt, Western Germany, India, Irak, Iran, Republic of Ireland, Japan, Malaysia, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, Union of Soviet Socialist Republics and the United Kingdom of Great Britain and Northern Ireland and dependent overseas territories),

by Dr. Ing. G. A. GAEBLER,

Ministerialrat in der Hauptverwaltung der Deutschen Bundesbahn (West Germany).

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I. PREAMBLE.

The combustion engine has been used to a larger extent for the propulsion of traction vehicles in railway operations for the last thirty years. Irrespective of the fact that the combustion engine represents a relatively recent technique in railway history, it is generally admitted that it now plays a quite important rôle in the traction service of the railways considered as a whole.

So far as the Reporter is aware, the only detailed papers since the original introduction of railcars with propulsion by combustion engine presented to the *International Railway Congress Association* by DUMAS and LEVY and STROEBE, respectively, were published in 1935 and 1937. The development of design and engineering principles as applied to this type of rolling stock and its structural elements was not allowed to rest and a number of improvements was achieved since that period. It was considered that the opportune moment had arrived to have a Report presented on the latest position of this class of rolling equipment. The *International Railway Congress Association,* therefore, decided to deal with questions concerning the design and improvement of railcars and multiple-unit diesel trains on the occasion of the Congress in 1958 in *Madrid.* A reporter each was designated for the Administrations employing the French and the English language in their correspondence with the *International Railway Congress Association,* who mutually elaborated a questionnaire, forwarded by the General Secretary to the Member Administrations on January 23rd, 1957. The purpose of this questionnaire was to obtain detailed information and the opinions of the Administrations on the subject in as uniform a manner as possible and compiled on the same uniform basis. The questionnaire was subdivided in three parts as follows:

Part I. General information concerning the use of railcars and trains composed of ordinary coaches hauled by diesel locomotives.

Part II. Detailed information concerning railcars built between the 1.1.1946 and 1.1.1957, under construction or design.

Part III. Ideas and opinions of the Administrations concerning the design and improvement of railcars.

The replies furnished by the English speaking Administrations to the questionnaire were compiled as shown below. Based on the information supplied to the questions in Part III of the questionnaire, the detailed information made available in reply to the questions in Parts I and II was used in making up the Report.

The questionnaire had to be made more voluminous then would ordinarily have been considered opportune, but this could not be avoided in view of the manifold engineering possibilities of design and use of diesel railcars. Particular stress was laid on the elaboration of Part II, and especially with the end in view to ensure the greatest possible precision in the replies by formulating the questions in detail and in a very concrete manner. The work occasioned to the Administrations was simplified to the greatest possible extent by stating the questions in such a way that in the majority of cases a simple reply by « yes » or « no » or deletion of the alternatives was sufficient.

It is with the deepest sense of gratitude that the Reporter wishes to emphasize the fact that the consulted Administrations spared no pains to be as generous in their replies as data available permitted, a considerateness that is most sincerely appreciated by the Reporter.

* * *

1. Introductory remarks.

The questionnaire jointly elaborated by both Reporters was forwarded by the General Secretary with letter dated January 23rd, 1957 to 36 Administrations, or affiliated organisations, employing the English language in their correspondence with the *International Railway Congress Associa-*

tion; a reply was received from 26 Administrations, or affiliated organisations, 7 of which stated that their experience with diesel railcars is as yet insufficient to enable them to answer to the questionnaire or that no railcars are in use in the region served by them.

The Railway Board of the Indian Government Administration stated that, for experimental purposes, 24 diesel railcars with one metre gauge have been used for the last two years and that another 24 railcars for broad gauge lines are on order. Replies to some of the questions included in the questionnaire were submitted. In addition, certain general information was supplied which has been used in the Report.

The Association of American Railroads (A.A.R.), instead of furnishing a reply to the questionnaire, submitted several journals containing articles dealing with diesel trains built in the United States of America.

Several Administrations stated their inability to reply to the questionnaire.

Detailed information was submitted by the following Administrations :

1. British Railways,
2. German Federal Railway,
3. Railway Administration of the Irish Republic (Irish Transport Company),
4. Japanese National Railways,
5. New Zealand Government Railways,
6. Norwegian State Railways,
7. Swedish State Railways.

The Report submitted herewith, therefore, is based chiefly on the information supplied by these 7 Administrations.

2. Summary of general information, with special attention to Diesel operations.

The total network of railway lines in service of the reporting Administrations comprises :

109 070 km, composed as follows :

15 812 km of single track main lines, standard and broad gauge,
23 134 km of multitrack main lines, standard and broad gauge,
38 946 km of main lines, standard and broad gauge;
28 968 km of single track secondary lines, standard and broad gauge,
12 530 km of multitrack secondary lines, standard and broad gauge,
41 498 km of secondary lines, standard and broad gauge;
28 626 km of narrow gauge lines, of which 25 696 km are located in non-European countries (3).

54 610 km, equal to 54 %, are also operated by diesel railcars or trains composed of ordinary coaches hauled by diesel locomotives (2).

The Administrations (2) reported the following performances in train-km or tonnes-km with the rolling stock in service during the year of 1956 :

TABLE 1. — **Summary of worked train-km.**

1	2	3	4	5
	million km	%	%	%
train-km	1 740	—	—	—
of which passenger trains	1 019	58.5	—	—
of which railcars and ordinary coaches hauled by diesel locomotives	187	10.7	18.3	
of which railcars	175	10	17.2	93

TABLE 2. — **Summary of worked tonnes-km** (4)

1	2	3	4	5
	thousand million tonnes-km	%	%	%
tonnes-km	426.5	—	—	—
of which passenger trains	88.0	20.6	—	—
of which railcars and ordinary coaches hauled by diesel locomotives . . .	6.42	1.5	7.3	—
of which railcars	5.36	1.3	6.1	83.5

Gas oil consumed by diesel railcars and trains composed of ordinary coaches hauled by diesel locomotives during 1956 amounted to approximately 159 000 tons (5), of which the consumption by railcars alone equalled about 100 000 tons, i.e., roughly 63 % of the total diesel fuel consumption.

The overall rolling stock in the traction service equipped with diesel engines amounts to 3 946 units (6), 2 980 of which are railcars.

The number of vehicles undergoing maintenance and repairs either at the depot or in repair shops varies rather considerably between 10 and 20 %; presumably, a different interpretation of the question was applied by some Administrations.

The average daily mileage varies between 166 and 420 km, in accordance with traffic requirements and geographical conditions prevailing in the different countries.

A summary of the values reported will be found in Table 3.

(1) Figures submitted by the Norwegian State Railways and the Railways of the Irish Republic are not included.

(2) Exclusive of figures quoted by the New Zealand Government Railways.

(3) Details submitted by the Railway Board of the Indian Government Administration are not included.

(4) Based on the figures quoted by the Swedish State Railways, the Japanese National Railways, and the German Federal Railway.

(5) Consumption by shunters of British Railways and the consumption of the New Zealand Government Railways are not included.

(6) The figures quoted by British Railways are exclusive of the number of shunting locomotives.

Comment on Tables 1 and 2.

In Column 3 are listed the shares in % of train-km and tonnes-km, respectively, run by :

(*a*) passenger trains,

(*b*) railcars and ordinary trains hauled by diesel locomotives.

(*c*) railcars alone,
out of the total of train-km and tonnes-km, respectively, of **all trains.**

In Column 4 are listed the shares in % of train-km and tonnes-km, respectively, run by :

(*a*) railcars and ordinary trains hauled by diesel locomotives.

(*b*) railcars alone,
out of the total of train-km and tonnes-km, respectively, of **passenger trains.**

In Column 5 is listed the share in % of train-km and tonnes-km, respectively, run by **railcars,** calculated on the overall performance of **railcars and diesel locomotives.**

TABLE 3. — GENERAL INFORMATION

ADMINISTRATIONS :	*British Railways*				*German Federal Railway*				*Railways of the Irish Republic*				*Norwegian State Railways*				*Swedish State Railways*				*Japanese National Railways*	*New Zealand Government Railways*			*Indian Government Railways*		
	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	narrow gauge lines	narrow gauge lines			narrow gauge lines		
	main lines	secondary lines	total		main lines	secondary lines	total		main lines	secondary lines	total		main lines	secondary lines	total		main lines	secondary lines	total			main lines	secondary lines	total	main lines	secondary lines	total
Length of lines in operation : single track (km)	1 652	6 774	8 426	—	5 697	12 036	17 733	—	1 043	1 571	2 614	—	4 315	—	4 315	—	3 105	8 587	11 692	—	—	—	—	—	80.45	476.13	556.58
multitrack (km)	9 327	12 421	21 748	—	12 442	109	12 651	—	360	—	360	—	64	—	64	—	941	—	941	—	—	—	—	—	—	—	—
total (km)	10 979	19 195	30 174	34	18 139	12 145	30 384	200	1 403	1 571	2 974	167	4 379	—	4 379	115	4 046	8 587	12 633	2 414	20 186	2 840	2 670	5 510	—	—	556.58
Track gauge (mm)	1 435	1 435	—	600-800	1 435	1 435	—	700-1 000	1 600	1 600	—	914	1 435	—	—	1 067	1 435	1 435	—	891-1 093	1 067	1 067	1 067	—	1 000	1 000	—
Admissible axle load (tons)	22.8	22.8	—	—	18-20	18-20	—	15-16	14-21	14-21	—	10	14-15	—	—	6	18	12-18	—	8-12	14	15	15	—	10.2	10.2	—
Length of lines operated by railcars and diesel trains (km)	4 413				26 571				—				—				10 969				9 457	3 200			no data		
Total of train-km run in 1956 ($\times 10^6$)	600.5				578.6				12.4				31.9				132				384.2	24.2			no data		
of which total passenger services	375.9				388.1				7.6				23.2				92				132.6	8.18 (mixed trains excluded)			no data		
railcars and diesel trains	10.9				92.5				6.2				6.0				34				37.1	no details available			no data		
railcars	10.7				87.3				2.7				5.7				32				36.8	2.18			no data		
Total number of tonnes-km in 1956 ($\times 10^9$)	no details				200.6				no details				—				37 (locomotives excluded)				188.9	6.4			no data		
of which total passenger services	—				68.3				no details				1.556				13.3				6.4	1.21			no data		
railcars and diesel trains	—				5.3				no details				—				0.84				0.28	no details available			no data		
railcars	—				4.4				no details				—				0.69				0.273	0.00941			no data		
Total diesel fuel consumption in 1956 for services on railway lines (tonnes-year)	9 544 (shunters excluded)				60 200				14 000				4 340				23 000				48 200	14 000			no data		
of which for railcars	8 962				39 000				2 700				3 450				15 000				30 700	—			no data		
Percentage of fuel consumption for railcars as against total fuel consumption for rail services (%)	94 (shunters excluded)				65				19.3				80				65				64	—			no data		
Cost of ton of diesel fuel in US $	45				104 (of which $ 48 taxes and Customs duties)				41				53.2				40				42	47.5			no data		
	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	Standard and broad gauge lines			narrow gauge lines	narrow gauge lines	narrow gauge lines			narrow gauge lines		
	main lines	secondary lines	total		main lines	secondary lines	total		main lines	secondary lines	total		main lines	secondary lines	total		main lines	secondary lines	total			main lines	secondary lines	total	main lines	secondary lines	total
Total number of vehicles with diesel engines (locomotives and railcars)	6	243	249 (shunters excluded)	—	348	793	1 141	3	—	—	147	7	—	—	95		—	—	775	280	1 033	—	—	216		no data	
of which railcars	—	242	242	—	138	778	916	—	—	—	66	4	—	—	90		—	—	422	177	1 013	—	—	50		no data	
average number of railcars available (stock in service and spares)	—	78	—	—	127	724	851	—	—	—	92.5	100	—	—	77.5		—	—	86	88	88.1	—	—	—		no data	
average daily number of railcars in service (%)	—	69	—	—	77	89	87	—	—	—	83	75	—	—	73.0		—	—	80.5	83	79.3	—	—	64		no data	
average number of railcars undergoing maintenance (%)	—	12	—	—	3.9	3.4	3.8	—	—	—	3.4	—	—	—	8.65 (*)		—	—	14	12	6.4	—	—	abt. 36 p.c		no data	
average number of railcars under repair (%)	—	10	—	—	4.1	3.6	3.0	—	—	—	7.6	—	—	—	11.8		—	—			5.5	—	—	no exact fig. avail.		no data	
Average daily mileage run by railcars (km)	—	355	—	—	335	325	326	—	—	—	352	166	—	—	200		—	—	200	170	332 (**)	—	—	420	798 Northern Railways	322 Southern Railways	

(*) The total number of railcars in maintenance and under repair was recently reduced to eighteen per cent.

(**) Calculated on the basis of average number of railcars available, average daily number of railcars in service, and average daily mileage run by all railcars.

3. Detailed information concerning railcars built between January 1st, 1946, and January 1st, 1957, under construction or design.

Railcars built and put into service in the post-war period are almost exclusively designed to be used for passenger transportation. The Swedish State Railways alone report having a railcar type for narrow gauge lines designed for use in freight traffic, of which 4 units are in service.

Passenger services ensured by diesel railcars cover a very wide field, having at the one extremity the very smallest units employed for stopping services on secondary lines, and very powerful multiple-unit sets worked in long-distance services and as luxury trains on main lines, at the other.

Commensurate with this operating programme and influenced by the variable requirements as they exist in the various countries and to which the railcars must conform, a multitude of types has been developed, frequently differing considerably in engineering features amongst each other.

There exist simple 4-wheel vehicles with a maximum speed of 70 km/h and a 60 HP engine, which are used without either trailer or control trailer. Commencing with a power output of approximately 125 HP, such vehicles are already put into service coupled to a trailer or control trailer; where they are of light construction, similar more or less to that of road buses, they are capable of an acceleration of up to 90 km/h. Depending on the composition of such trains, anywhere from 60 to 280 seats, plus additional space for luggage, can thus be made available.

Designs of the intermediate class, with an overall power output of from 400 to 500 HP, supplied either by a single engine or by two smaller engines, are most generally put into service jointly with trailers and control trailers, respectively. Their design predominantly embodies bogies, and they usually have 1st class accommodations and also a restaurant service, whilst frequently gangways between units permit free passenger passage. Their field of application includes stopping services, regional services, and also fast services on main as well as on secondary lines. Maximum speeds are in the vicinity of 120 km/h.

High-capacity designs are invariably multiple-unit sets with maximum speeds of up to 140 km/h and a built-in power supply of up to 2 200 HP available in two engines of 1 100 HP each. They are chiefly used on main lines as luxury trains or in long-distance express service, but to some extent also in ordinary express service. They differ amongst each other not only as regards the interior layout aided by structural features, but also in their riding qualities and supplementary facilities intended to improve the passenger's comfort.

Detailed information on railcar and multiple-unit set designs has been compiled in Tables 4 *a*) to *d*).

In view of the large number of different types and in order to avoid the loss of lucidity of the Table, the designs represented in the Table were selected in such a manner that, all things being more or less equal from an engineering standpoint, one representative type only was chosen for a group of very similar designs, supplementary details being confined to a foot-note, where it seemed opportune.

Photos of several railcars and multiple-unit sets as well as their drawings have been inserted at the end of this report for illustration.

II. IDEAS AND OPINIONS OF THE ADMINISTRATIONS CONCERNING THE DESIGN AND IMPROVEMENT OF RAILCARS.

1. Sphere of use of railcars.

11. *What reasons guide you in your choice of services to be worked by railcars?*

The choice of lines to be worked by railcars is based on operational, commercial, and economical considerations. The specific reason given for the use of diesel railcars by the Railways of the Irish Re-

TABLE 4*a*. — SUMMARY OF RAILCA

OWNER ADMINISTRATION :			*BRITI*
Type		ACV Non-Bogie	Derby Light-Alloy (Leyland)
Normal composition of set (1)		M.U. + T. + M.U.	M.U. + M.U.
Design of gangways between units		no gangways	bellows
Maximum speed	km.p.h.	72	104
Built-in power per railcar	HP	125	2 engines of 140 H
Number of existing units of this type : *a*) Motor units	—	5	16
b) Trailers	—	3	—
c) Control trailers	—	—	—
Repeat orders contemplated	—	yes	no
Chief use on		secondary lines passenger traffic stopping services	secondary lines passenger traffic express services stopping services
Number of seats 1st/2nd class : *a*) Motor unit	seats	—/31	16/114 (MU + MU
b) Trailer	seats	—/48	—/—
c) Control trailer	seats	—/—	—/—
Luggage compartment	m^2	5.8 in M.U.	8 in M.U.
Supplementary space for particular purposes	—	—	—
Tare : *a*) Motor unit	tons	29.7	28 each M.U.
b) Trailer	tons	10.6	—
c) Control trailer	tons	—	—

(1) Definition of abbreviations : M.U. = motor unit. — T. = trailer. — C.T. = control trailer.
(2) Other sets in operation M.U. + T. + T. + M.U. and isolated M.U. with 2 driving positions.
(3) An identical railcar « Metropolitan Cammell (R.R.) » with two engines of 180 HP each is in preparation.
(4) A separate standard set is : M.U. + T. + T. + M.U. or M.U. + T. + M.U.
(5) An identical railcar « Derby R.R. » with two engines of 238 HP each is in preparation.

ERATION AND IN PREPARATION

WAYS

y Light Alloy	Metropolitan-Cammell (AEC)(3)	Craven	Derby Steel (5)	Swindon	Southern Diesel-Electric
. + C.T. (2)	M.U. + C.T. (4)	M.U. + C.T.	M.U. + C.T.	4 M.U. + 2 T.	2 M.U. + 4 T.
bellows	bellows	bellows	bellows	bellows	bellows
104	104	104	104	104	120
ines of 150 HP	2 engines of 150 HP	2 engines of 150 HP	2 engines of 150 HP	2 engines of 150 HP	500
106	58	6	21	0	0
10	14	—	—	0	0
85	36	6	21	—	—
no	yes	yes	yes	yes	—
ondary lines senger traffic ress services onal and pping services	secondary lines passenger traffic regional and stopping services	secondary lines passenger traffic regional and stopping services	secondary lines passenger traffic regional and stopping services	main lines passenger traffic express services	main lines passenger traffic express services other fast services regional services
—/52	—/56	—/52	—/62	—/52 (tot.—/208)	0/22 (tot. 0/44)
—/—	—	—	—	30/— (tot. 60/—)	10/39 (tot. 42/156)
12/53	16/53	12/51	12/62	—	—
10.1 in M.U.	10.64 in M.U.	13 in M.U.	13 in M.U.	7.5 in M.U.	12.5 in M.U.
—	—	—	—	restaurant 12 seats	—
27.2	31.6	29	36	38.6	55 (total 110)
—	—	—	—	34.4	30 (total 119.3)
20.9	24.6	23.1	30	—	—

(contd.)

TABLE 4*a*. — **SUMMARY OF RAILCA**

OWNER ADMINISTRATION :			*BRITI*
Radius of action of standard set	km	300	800
Built-in power in proportion to service, weight of standard set	HP/tons	6.1	9.76
Built-in power in proportion to gross weight of standard set (service weight plus load)	HP/tons	5.6	8.35
Residual acceleration on the level at maximum speed for the standard set	m/sec²	0.07	0.0962
Maximum speed on a gradient : of 10 °/₀₀	km.p.h.	63.5	100
of 25 °/₀₀	km.p.h.	26.0	54
Average annual mileage per railcar	km	57 000	104 000
Average mileage between : successive inspections	km	no experience	no experience
successive general overhauls	km	no experience	no experience
Average mileage in service between two cases of more severe damage	km	no experience	no experience
Average annual cost of maintenance and repair in per cent of capital cost : *a*) Motor unit	p.c.	no details available	no details availab
b) Trailer	p.c.	no details available	no details availab
c) Control trailer	p.c.	no details available	no details availab

(1) Definition of abbreviations : M.U. = Motor unit. — T = trailer. — C.T. = control trailer.
(2) Other sets in operation M.U. + T. + T. + M.U. and isolated M.U. with 2 driving positions.
(3) An identical railcar « Metropolitan Cammell (R.R.) » with two engines of 180 HP each is in preparation.
(4) A separate standard set is : M.U. + T. + T. + M.U. or M.U. + T. + M.U.
(5) An identical railcar «Derby R.R. » with two engines of 238 HP each is in preparation.

public, the Swedish State Railways, and the Norwegian State Railways is that this type of passenger equipment, due to size and seating capacity, is the most suitable to traffic requirements existing in these countries and hence very economical to operate.

British Railways use railcars especially on branch lines in view of the need of improved amenity (e.g., more frequent service and introduction of intermediate unattended halts) with the object of holding and increasing custom and thus to improve, or restore, the earning capacity of these lines.

PERATION AND IN PREPARATION *(continued)*.

WAYS						
800	800		800	800		800	1 288
6.15	5.17	6.12 (3)	5.64	4.5	6.4 (5)	5.3	4.16
5.2	4.46	5.28 (3)	4.86	3.9	5.62 (5)	4.84	3.86
0	0		0	0		0.0465	—
63.5	59.5	72.5 (3)	63.5	42	74 (5)	66	60
24.0	24	27.0 (3)	24.0	24	37 (5)	24	32
84 000	84 000		no experience	no experience		no experience	no experience
no experience	no experience		no experience	no experience		no experience	no experience
no experience	no experience		no experience	no experience		no experience	no experience
no experience	no experience		no experience	no experience		no experience	no experience
details available	no details available		no details available	no details available		no details available	no details available
details available	no details available		no details available	no details available		no details available	no details available
details available	no details available		no details available	no details available		no details available	no details available

In suburban and inter-city traffic, British Railways, aside from the reasons cited in the preceding paragraph, prefer the use of railcars on lines where traffic density makes electrification uneconomic.

The Japanse National Railways increasingly employ railcars with the object of improving services for passengers and reducing operating expenses.

12. *Do you think it is more economic to multiply the number of railcar services replacing a heavy rake hauled by a diesel locomotive in the case of short term traffic requirements? Why?*

TABLE 4*b*. — SUMMARY OF RAILCA

OWNER ADMINISTRATION :			GERM
Type		VT 95.9	VT 98.9
Normal composition of set (1)	—	M.U. + T	M.U. + T + C.T
Design of gangways between units	—	—	—
Maximum speed	km.p.h.	90	90
Built - in power per railcar	HP	135 - 150	2 engines of 150 H
Number of existing units of this type : *a*) Motor units	—	568	153
b) Trailers	—	566	220
c) Control trailers	—	—	30
Repeat orders contemplated	—	no	yes
Chief use on		passenger traffic secondary lines stopping services	passenger traffic secondary lines stopping services
Number of seats 1st/2nd class : *a*) Motor unit	seats	—/60	—/60
b) Trailer	seats	—/35	—/40
c) Control trailer	seats	—	—/40
Luggage compartment	m^2	7.5 in T	12.5 in T 12.5 in C.T.
Supplementary space for particular purposes	—	—	—
Tare : *a*) Motor unit	tons	13.4	19.5
b) Trailer	tons	7.6	9.9
c) Control trailer	tons	—	10.4

(1) Definition of abbreviations : M.U. = motor unit. — T = trailer. — I.T. = inserted trailer. — C.T. = control trailer

(2) Depends on mechanical equipment.

(3) Space for customs clearance, secretariat, and train telephone service.

(4) Depends on mechanical equipment. — (5) Depends on mechanical equipment.

PERATION AND IN PREPARATION

RAL RAILWAY

VT 08.5	VT 10.5	VT 10.55	VT 11.5	VT 12.5
U. + I.T. + C.T.	2 M.U. + 5 I.T.	2 M.U. + 6 I.T.	M.U. + 5 I.T. + M.U.	M.U. + I.T. + C.T.
bellows	bellows	bellows	bellows	bellows
140	120	120	140	120
1 000 — 1 100	2 engines of 210 HP	2 engines of 210 HP	1 100	1 000 — 1 100
20	2	2	19	12
22	5	6	40	13
8	—	—	—	9
yes	no	no	yes	yes
main lines passenger traffic ress long dist. serv.	main lines passenger traffic luxury train (exper. set)	main lines passenger traffic luxury train	main lines passenger traffic luxury train	main lines passenger traffic express services
dining room 24/-	30/—	sleeping car train	service space	—/44
60/-	101/—	special equipment	total of 122 + 53 in	18 — 24/71 — 72
54/—	—	—	dining room	24/47 — 60
10 in M.U.	8 in M.U.	8 in M.U.	20 in M.U.	11 in M.U.
chen a. din. accom.	kitchen a. dining accom.	kitchen a. dining accom.	kitch. a. din. accom. (3)	—
50 — 53 (2)	30.25	29.4	43 — 46 (4)	48 — 51 (5)
32.3	10.8	9.8 — 11.1	22 — 24	30.5
32.9	—	—	—	30.6

(contd.)

TABLE 4*b*. — SUMMARY OF RAILCARS

OWNER ADMINISTRATION :			GERM
Radius of action of standard set	km	500	600
Built - in power in proportion to service weight of standard set	HP/tons	6.25 - 6.94	7.34
Built - in power in proportion to gross weight of standard set (service weight plus load)	HP/tons	4.8 - 5.2	5.86
Residual acceleration on the level at maximum speed for the standard set	m/sec²	0.06/0.07	0.13/0.14
Maximum speed on a gradient : of 10 °/₀₀	km.p.h.	63	70
of 25 °/₀₀	km.p.h.	33	37
Average annual mileage per railcar	km	114 000	105 000
Average mileage between : successive inspections	km	3 550	3 000
successive general overhauls	km	300 000	230 000
Average mileage in service between two cases of more severe damage	km	96 300	100 000
Average annual cost of maintenance and repair in per cent of capital cost : *a*) Motor unit	p.c.	12	13
b) Trailer	p.c.	7	7
c) Control trailer	p.c.	—	8 - 9

(1) Definition of abbreviations : M.U. = motor unit. — T = trailer. — I.T. = inserted trailer. — C.T. = control trailer
(2) Depends on mechanical equipment. — (3) Space for customs clearance, secretariat, and train telephone service.
(4) Depends on mechanical equipment. — (5) Depends on mechanical equipment.

In general, the Administrations in this case favour the use of railcars in view of the greater speed of this type of equipment, as compared with engine-hauled rakes, and the improved turn-round time. The decision whether or not it is preferable to use railcars or engine-hauled heavy rakes, however, also depends on the line capacity, i.e., on the consideration whether or not the latter is suitable to the working of a larger number of railcar services instead of a *single* heavy engine-hauled rake.

In the event, however, that at periods of increased traffic requirements, especially if they are very considerable, a locomotive not otherwise needed is available, it may be better and more economical to use this with standard coaches.

PERATION AND IN PREPARATION *(continued)*.

RAL RAILWAY				
1 300	1 300	1 300	2 700	1 100
8.1 — 8.9	7.0	6.56	10.2	8.1 — 8.9
7.6 — 8.4	6.46	6.37	9.7	7.6 — 8.4
0.067	0.06	0.049	0.07	0.07
115	80	75	125	115
57	42	38	70	57
264 000	no details available	179 000	no experience yet	212 000
9 000	experimental set	7 350	no experience yet	7 000
332 000	experimental set	291 000	no experience yet	317 000
170 000	experimental set	238 000	no experience yet	83 000
20	experimental set	16	no experience set	20
9	experimental set	—	no experience yet	9
11	experimental set	—	no experience yet	11

In the opinion of the German Federal Railway, each individual case should be evaluated on the basis of the specific operating conditions.

13. *To what extent do you consider it advisable to use railcars with a large transport capacity running as multiple units with trailers? Why?*

In consideration of the versatility of railcars in operation, they are usually constructed in a manner to permit their utilisation in various combinations, ranging from the solitary railcar to long multiple-unit trains.

The use of a railcar as a self-contained unit is conditioned upon its being provided with a driving position at both ends

TABLE 4*c*. — **SUMMARY OF RAILCA**

Owner Administrations :		*Railways of the Irish Republic*	*Norwegian*
Type		IA - AI	Type 88
Normal composition of set (1)		M.U.+ 2T.+M.U.(1)	M.U.+ I.T.+ M.U
Design of gangways between units		bellows	bellows
Maximum speed	km.p.h.	116	120
Built - in power per railcar	HP	2 engines of 125 HP	650
Number of existing units of this type : *a*) Motor units	—	66	8
b) Trailers	—	72	4
c) Control trailers	—	2	—
Repeat orders contemplated	—	no	yes
Chief use on		main α second. lines passenger traffic expr. long dist. serv. expr. α other fast serv. regional and stopping service	main lines passenger traffic expr. long dist. serv
Number of seats 1st/2nd class : *a*) Motor unit	seats	12/32	—/2 × 46 - 92
b) Trailer	seats	—/70	—/70
c) Control trailer	seats	—/60	—
Luggage compartment	m^2	8.5 in M.U. 8.5 in C.T.	13.0 in M.U.
Supplementary space for particular purposes		kitchen 8.5 m^2 pantry 6.5. m^2	kitchen
Tare : *a*) Motor unit	tons	39.5	43.8
b) Trailer	tons	26	28.0
c) Control trailer	tons	28	—

(1) Definition of abbreviations : M.U. = motor unit. — T = trailer. — I.T. = inserted trailer. — C.T. = control trai
(2) Maximal admissible speed. — (3) Variable layout in car body. — (4) Values applicable to railcar running alone.
(5) It would seem that the reply furnished by the Swedish State Railways is based on a wrong interpretation of the questi

PERATION AND IN PREPARATION

Railways	*Swedish State Railways*		*New Zealand Government Railways*	*Indian Government Railways*	
Bmdo 86 f	YBo 6 and YBo 7	YBo5 p α YBo5 p	Rm 100 — 134	CSC — 980	CSC — 1047
I.U. + C.T.	M.U. + T.+ C.T.	M.U. + T. + C.T.	M.U. + M.U.	M.U. + M.U.	M.U. + M.U.
gangway	gangways	gangways	gangway	no gangway	no gangway
100	115	85	96	80.5 | 96.56	—
gines of 204 HP	205	166	2 engines of 210 HP	185 | 180	2 engines of 200 HP
20	216	63	35	24	in preparation
—	117	11	—	—	—
20	108	39	—	—	—
no	yes	yes	yes	—	—
ondary lines ssenger traffic ional and opping services	secondary lines passenger traffic other fast services regional and stopping services	secondary lines passenger and freight traffic regional and stopping services	main α second. lines passenger traffic express services regional and stopping services	secondary lines passenger traffic	—
—/70	—/53 —/47	—/42	—/88	—/73	—/84
—	—/up to 62 (3)	—/—	—/—	—/—	—
—/68	—/31 — 36 (3)	—/32 — 50	—	—	—
6.2 in C.T.	up to 40 m² in T. 12.5-17 m² in C.T.(3)	36 in T. 24 in M.U. up to 12.5 in C.T.	—	—	—
—	pantry 4.5 m²	—	—	—	—
30.4	18	13.7	57	27.0 | 30.0	47.0
—	13 — 15	10 — 11	—	—	—
19.0	14 — 15	11	—	—	—

(contd.)

TABLE 4c. — SUMMARY OF RAILCAR

Owner Administrations :		*Railways of the Irish Republic*	*Norwegia*
Radius of action of standard set	km	1 000	600
Built - in power in proportion to service weight of standard set	HP/tons	4.42	10.66
Built - in power in proportion to gross weight of standard set (service weight plus load)	HP/tons	3.92	9.66
Residual acceleration on the level at maximum speed for the standard set	m/sec²	0.09	—
Maximum speed on a gradient : of 10‰	km.p.h.	40	100 (2)
of 25‰	km.p.h.	25	70
Average annual mileage per railcar	km	97 000	100 000
Average mileage between : successive inspections	km	194 000	200 000
successive general overhauls	km	388 000	600 000
Average mileage in service between two cases of more severe damage	km	66 000	no details available
Average annual cost of maintenance and repair in per cent of capital cost : *a*) Motor unit	p.c.	15.3	no details available
b) Trailer	p.c.	8.3	no details available
c) Control trailer	p.c.	8.3.	no details available

(1) Definition of abbreviations : M.U. = motor unit. — T = trailer. — I.T. = inserted trailer. — C.T. = control trailer. -
(2) Maximal admissible speed. — (3) Variable layout in car body. — (4) Values applicable to railcar running alone. -
(5) It would seem that the reply furnished by the Swedish State Railways is based on a wrong interpretation of the questio

of the vehicle, basing this on the premise that an inversion of travelling direction by turn-tables, a Y or a reversing loop at terminal stations should by all means be avoided. Railcars of such construction are available in Japan, Great Britain, Norway, Sweden, and West Germany. If a larger seating capacity is required, a second self-contained railcar, a trailer, or a control trailer may be added. In the first instance, multiple control is required for reasons of economy and to obviate additional personnel. Working two self-contained railcars as a multiple-unit train has the advantage that the ratio « power output/weight to be moved » remains constant. In this connection it will be noted that the Japanese National Railways have

ERATION AND IN PREPARATION *(continued)*.

Railways	Swedish State Railways		New Zealand Government Railways	Indian Government Railways	
500	600 — 700	400 — 500	600	—	—
8.2	11.2 (4)	11.8 (4)	6.9	—	—
6.76	9.2 (4)	9.66 (4)	6.2	—	—
—	0.02 (4)	0.15 (4)	—	—	—
75	85 — 90	85	—	—	—
40	—	55	—	—	—
85 000	90 000	75 000	—	—	—
80 000	75 000	—	—	—	—
240 000	300 000	—	—	—	—
details available	no details available	—	—	—	—
details available	240 (5)	—	—	—	—
details available	100 (5)	—	—	—	—
details available	—	—	—	—	—

available self-contained railcars only. The advisability of using trailers in conjunction with self-contained railcars has been taken into consideration only recently.

Coupling a trailer or a control trailer to a motor unit offers the advantage of a lower capital investment. On the other hand, the use of trailers has the disadvantage of requiring a re-arrangement of the units in a multiple-unit train, wherever the travelling direction is reversed.

If it is already known at the planning stage that the passenger demand exceeds the capacity of a single railcar, the units to be made up into basic components, as for instance: motor unit plus motor unit, or motor unit plus control trailer, are constructed in such a manner that a driving

TABLE 4*d*. — SUMMARY OF RAILCAR

OWNER ADMINISTRATION :			*JAPANES*
Type		KIHA 03 standard design for KIHA 01, 02, 03	KIHA 06
Normal composition of set (1)		M.U.	M.U.
Design of gangways between units		no gangway	no gangway
Maximum speed	km.p.h.	70	85
Built - in power per railcar	HP	60 resp. 75	100
Number of existing units of this type : *a*) Motor units		12 + 17 + 20 = 49	50
b) Trailers		—	—
c) Control trailers	—	—	—
Repeat orders contemplated	—	yes	no
Chief use on		secondary lines passenger traffic regional and stopping services	secondary lines passenger traffic regional and stoppin services
Number of seats 1st/2nd class :			
a) Motor unit	seats	—/40	—/62
b) Trailer	seats	—	—
c) Control trailer	seats	—	—
Luggage compartment	m^2	—	—
Supplementary space for particular purposes	—	—	—

(1) Definition of abbreviation : M.U. = motor unit.

(2) These values would seem to be too low, presumably due to a misinterpretation of the question.

(3) Values for KIHA 03.

(4) KIROHA 18, 1st class – 32 seats; 2nd class = 44 seats; KIHAYUNI 16 (modifiied design), 2nd class = 62 seats.

PERATION AND IN PREPARATION

ONAL RAILWAYS

KIHA 07	KIHA 09	KIHA 17 standard design for KIHA 10, 11, 12, 15, 16, 17, 18, 19 KIHAYUNI 16 KIROHA 18	KIHA 20 standard design for KIHA 20, 21, 25, 26 KIROHA 25 KIHAYUNI 25	KIHA 51 standard design for KIHA 50 and 51	KIHA 55
M.U.	M.U. + M.U.	M.U.; M.U.+M.U.; M.U.+M.U.+M.U.	M.U.; M.U.+M.U.	M.U. + M.U.	M.U. + M.U.
no gangway	bellows	bellows	bellows	bellows	bellows
95	95	95	95	95	95
	150	160	160	2 engines of 160 HP	2 engines of 160 HP
63	15	725	0	22	5
—	—	—	—	—	—
—	—	—	—	—	—
no	no	yes	under construction	KIHA 50 no, KIHA 51 yes	yes
ondary lines ssenger traffic gional and pping services	secondary lines passenger traffic regional and stopping services	secondary lines passenger traffic regional and stopping services	secondary lines passenger traffic regional and stopping services	secondary lines passenger traffic express services other fast services region. α stopping s.	main lines passenger traffic express services other fast services
—/72	—/84	—/74 — 88 (4)	KIROHA 25 32/42 —/70 KIHAYUNI 25 —/40	KIHA 50 : —/92 KIHA 51 : —/80	—/84
—	—	—	—	—	—
—	—	—	—	—	—
—	—	KIHAYUNI 16 only 14.4	KIHAYUNI 25 only 22.8	—	—
—	—	—	—	—	—

(contd.)

TABLE 4*d*. — **SUMMARY OF RAILCAR**

OWNER ADMINISTRATION :			*JAPANES*
Tare : *a*) Motor unit	tons	10.5	22.33
b) Trailer	tons	—	—
c) Control trailer	tons	—	—
Radius of action of standard set	km	81.9 (2)	124 (2)
Built - in power in proportion to service weight of standard set	HP/tons	6.0	3.8
Built - in power in proportion to gross weight of standard set (service weight plus load)	HP/tons	4.8 (3)	3.23
Residual acceleration on the level at maximum speed for the standard set	m/sec²	0.0236	no details available
Maximum speed on a gradient : of 10 °/₀₀	km.p.h.	55	no details available
of 25 °/₀₀	km.p.h.	45	no details available
Average annual mileage per railcar	km	identic. with KIHA 17	identic. with KIHA 1
Average mileage between : successive inspections	km	identic. with KIHA 17	identic. with KIHA 1
successive general overhauls	km	identic. with KIHA 17	identic. with KIHA 1
Average mileage in service between two cases of more severe damage	km	identic. with KIHA 17	identic. with KIHA 1
Average annual cost of maintenance and repair in per cent of capital cost : *a*) Motor unit	p.c.	identic. with KIHA 17	identic. with KIHA 1
b) Trailer	p.c.	—	—
c) Control trailer	p.c.	—	—

(1) Definition of abbreviation : M.U. = motor unit.

(2) These values would seem to be too low, presumably due to a misinterpretation of the question.

(3) Values for KIHA 03.

(4) KIROHA 18, 1st class = 32 seats; 2nd class = 44 seats; KIHAYUNI 16 (modified design), 2nd class = 62 seats.

ERATION AND IN PREPARATION *(continued)*.

NAL RAILWAYS					
27.0	34.6	28.9 — 32.7	abt. 30 — 31	abt. 35	35.38
—	—	—	—	—	—
—	—	—	—	—	—
124 (2)	49.7 (2)	122.7 (2)	—	122.7 (2)	122.7 (2)
4.86	3.78	4.52	—	7.7	7.96
4.14	3.26	3.9	—	6.6	6.96
tails available	no details available	—	no details	—	—
tails available	no details available	52.0	no details	—	—
tails available	no details available	23.5	no details	45	45
ic. w. KIHA17	identic. w. KIHA17	88 805	no details	identic. w. KIHA17	identic. w. KIHA17
ic. w. KIHA17	identic. w. KIHA17	52 895	no details	identic. w. KIHA17	identic. w. KIHA17
ic. w. KIHA17	identic. w. KIHA17	121 210	no details	identic. w. KIHA17	identic. w. KIHA17
ic. w. KIHA17	identic. w. KIHA17	75 000	no details	identic. w. KIHA17	identic. w. KIHA17
ic. w. KIHA17	identic. w. KIHA17	abt. 8	no details	identic. w. KIHA17	identic. w. KIHA17
—	—	—	—	—	—
—	—	—	—	—	—

position is provided only at both ends of the multiple-unit train, this being considered a unit and excluding the possibility of being broken up into its component parts and worked separately in regular operations. Compositions of the most varied nature are known, as for instance placing a trailer between a motor unit and a control trailer or one or several trailers between two motor units at each end of the multiple-unit train; moreover, two or more multiple-unit trains formed in this manner may be coupled, thus permitting a highly graduated adaptation of seating capacity to passenger demand. British Railways, for instance, have available basic multiple-unit trains composed as follows :

motor unit plus motor unit,
motor unit plus trailer plus motor unit,
motor unit plus control trailer,
motor unit plus 2 trailers plus motor unit,
motor unit plus 4 trailers plus motor unit,
motor unit plus trailer plus motor unit plus motor unit plus trailer plus motor unit.

Multiple-unit trains of the German Federal Railway, inter alia, are worked in the following composition :

motor unit plus 5 to 8 trailers plus motor unit.

The possibility of varying seating capacity within broad limits may be demonstrated on the basis of the double-engined railbus of the German Federal Railway, type VT 98.9, as follows :

Train composition.	Seating capacity.
single railcar (motor unit)	60
motor unit plus control railcar	100
motor unit plus motor unit	120
motor unit plus trailer plus control trailer	140
motor unit plus trailer plus motor unit.	160
motor unit plus 2 trailers plus motor unit	200
motor unit plus 3 trailers plus motor unit	240
motor unit plus 4 trailers plus motor unit	280

2. Standardisation of railcars.

21. *Are you tending to standardise as much as possible by only using a limited number of classes of railcars and engines?*

In general, the answer given by the Administrations to this question is in the affirmative.

British Railways note specifically that it is the intention to keep to a standard range of units for :

(*a*) cross-country and branch lines,
(*b*) suburban or cross-country service,
(*c*) fast inter-city service.

On the basis of data made available, the railcars of *British Railways* may be subdivided in the following three groups (cf. Table 4) :

Group 1 : ACV Non-Bogie.
Group 2 : Derby Light-Alloy (Leyland),
Derby Light-Alloy (AEC),
Metropolitan-Cammell (AEC),
Metropolitan-Cammell (RR),
Craven,
Derby Steel,
Swindon.
Group 3 : Southern Diesel-Electric.

The type in groupe 1 is predominantly used in short-haul traffic and corresponds therefore to the purpose listed under (*a*) for cross-country service and on branch lines.

The types in group 2 are, depending on the composition of trains of motor-units, trailers, and control trailers, partly used in cross-country and short-haul traffic, but partly also in express and other rapid services.

The type in group 3 is used exclusively in fast inter-city service.

Groups 1 and 3 comprise only one type each, whilst group 2 is composed of 8 types. A closer inspection, however, shows that the eight types listed here may be considered as one for the reason that the different types closely resemble one another

in the matter of maximum speed, seat availability, auxiliary space, power output, and a large number of structural components, whilst deviations exist only in the arrangement of seats (layout) and with reference to a higher engine power with 2 of the types listed.

In actual operations there are, therefore, only three types used each for a specific purpose, with the exception of the type in group 2 which may be used for various purposes.

The *Norwegian State Railways* possess two types, i.e., one each for long-haul express services and cross-country and short-haul traffic.

The *Swedish State Railways* use one type with two different internal layouts on standard gauge track, the difference being only in the seat arrangement. It is used in rapid service, regional, and short-haul traffic.

The *Japanese National Railways* own a larger number of types arranged in standard types by groups. The total comprises eight standard types, six of which are predominantly used in cross-country and short-haul traffic, whilst the remaining two are used for rapid services. Standard type KIHA 17, noticeable already for the large number of railcars of this type available, deserves special mention. It represents the basic design of classes KIHA 10, 11, 12, 15, 16, 17, 18, 19, KIHA-YUNI 16, and KIROHA 18. In all these classes, important structural components, as for instance, engine, transmission, running gear, etc., are fully identical, the body alone differing somewhat in accordance with type of service. There are, for instance, railcars with no, one, or two driving positions, whilst another characteristic is the arrangement in view of low ambient temperatures. Similar to the class represented by the type KIHA 17, there is type KIHA 20, the basic design of railcars of type KIHA 20, 21, 25, 26, KIROHA 25, and KIHA-YUNI 25, equipped with the same engine and transmission as all railcars of standard type 17. Types KIHA 51 and 55, somewhat longer, are equipped with two engines, all other mechanical components being of the same design as those used in single-engined types.

The *German Federal Railway* distinguishes for utilisation purposes between :

(1.) regional and short-haul service,
(2.) rapid service,
(3.) long-haul rapid service and « TEE » (Trans-European) services.

For the service listed under (1.), the so-called « railbus » is made available. It exists in two types, VT 95.9 and VT 98.9, differing in power output only and in that type VT 98.9 is equipped with standard buffers and draw gear. Type 98.9 is equipped with two engines and has, therefore, double the power output of type 95.9.

In average-haul semi-rapid and rapid passenger service one type is provided, i.e., VT 12.5.

In long-distance rapid passenger service type VT 08.5 is used, which differs from type VT 12.5 merely in the interior equipment. Both types are perfectly identical, so far as construction of the body, the bogies, and the mechanical equipment is concerned, so that it would be quite justifiable to consider them as one type.

Mention should also be made of the Trans-Europ-Express multiple-unit diesel trains, type VT 11.5, and the articulated multiple-unit diesel trains (Gliedertriebzüge), types VT 10.5 and VT 10.55, these latter being experimental designs existing in one unit each only, for which reason they may be considered as not particularly important to operations.

Type VT 11.5 differs from both VT 08.5 and VT 12.5 so far as construction and interior equipment are concerned; however, the engine and other component parts are identical with all three types, thus maintaining standardisation to the greatest possible extent.

It will be noted that the endeavour emphasized by the Administrations to standardise and to keep to the smallest possible number of types is reflected in the equipment actually in use.

22. *Have you looked into construction arrangements which make it possible to standardise the engine and equipment components?*

This question is answered in the affirmative by all Administrations.

Every possibility available to the Administrations to standardise engines and other mechanical equipment was, as is fully corroborated by the answers to the questionnaire, utilised to the full in the construction of this class of rolling stock. To illustrate: the same engine and transmission types are used by British Railways in their railcars Derby Light Alloy (AEC), Metropolitan Cammell (AEC), Craven, Derby Steel, Swindon; by the Japanese National Railways in 19 types of their railcars; and by the German Federal Railway in their railcar sets VT 08.5, VT 11.5, and VT .12.5. (The latter also use the same engine and transmission types in two types of diesel locomotives.) It will, moreover, be noted that, although the German Federal Railway utilises three different engine types and two different transmission types in the power range of 1 000 HP, their installation and connection dimensions are held uniformly to the same standards, so that they are at all times fully interchangeable not only between the several railcar and locomotive types, but also between the two classes of traction vehicles.

The Norwegian State Railways call attention to the fact that less recent types of railcars were re-equipped in order to standardise engines and other mechanical equipment.

3. IMPROVEMENT OF RAILCARS.

31. Motor power equipment (engine and transmission) (*).

311. *In view of the cost of maintenance and the possible consequence of damage on regularity of working, do you stipulate two engines of lower power instead of a single engine on railcars in certain cases?*

The Administrations of the Railways of the Irish Republic, Norway, Japan, Great Britain, and West Germany have equipped part of their railcar stock with power and transmission units in duplicate.

The Administration of the Norwegian Railways and the German Federal Railway recommend the use of duplicate traction installations also for reasons of operational safety. This procedure offers the advantage that on the one hand the train will be able to clear the track without outside help in case of damage, whilst on the other it will usually be possible to have the train proceed to its final destination with only half the power, although a delay may result.

The Japanese National Railways provide their standard type KIHA 51 and 55 with two engines in order to improve acceleration on hilly sections and on lines with high density of traffic and to enable the addition of a trailer on lines near large cities, if passenger demand makes this necessary.

The choice of the number of engines will be determined by the overall of installed power required and size of engines available on the market. A further determining factor is the positioning of engine. If underfloor positioning is selected, the installation of two smaller engines of lower power will frequently be unavoidable.

The German Federal Railway states that the choice of two — and in some cases even more — engines taken from serial production in the motor vehicle industry may easily be less expensive than a single large unit chosen from the general engine manufacturing programme.

So far as maintenance costs are concerned, however, both the Japanese National Railways and the German Federal Railway are of the opinion that a *single* large engine will prove less costly to main-

(*) Tables 5 *a*) to *d*) show types of engines used by the Administrations in their railcars.

tain. Thorough investigations carried out by the Workshop Service of the latter have shown beyond doubt that maintenance costs are in a definite relation to number of cylinders and much less so to the size of cylinders.

312. *Do you prefer two stroke or four stroke engines, fast or slow?*
What is the reason for your preference?

In railcars, the Administrations have up to now used four stroke engines *exclusively*, as, in accordance with information supplied by British Railways, this is the type of construction available on the market in far greater number than the two stroke engine. This reason probably also applies to the Administrations of the other countries. The Administration of the Swedish State Railways states in this connection that the question of two or four stroke engines is less important, so long as products of well-known manufacturers are used.

Relative to the engine speed, the answers to the questionnaire show that the Administrations generally prefer engines with a speed of from 1 500 to 2 000 r.p.m., the lower speed applying to engines with higher power and the higher speed to those with lower power.

British Railways are developing a railcar with electric transmission (type Southern Diesel-Electric), which it is intended to equip with an engine of 500 HP with a speed of 850 r.p.m.

In view of the fact, that fast engines have a high specific power output, they are generally preferred to slow engines in railcar construction, taking into consideration the lack of space prevailing in these vehicles.

The question of possible advantages due to lower weight, lower first cost and, consequently, lower operating expenses is not dealt with in the replies to the questionnaire.

A frequently encountered engineering principle to raise the specific power output is the application of supercharging. It has been applied up to now to engines of fairly high rating (in excess of 200 HP) by the Railways in Germany, Sweden, Norway, and also Great Britain, by the latter with an experimental railcar and with the previously cited diesel-electric railcars. The power output boost obtained with supercharging varies between 25 and 58.8 %. The German Federal Railway also applied supercharging to engines of a lower rating (135 HP), the rate of supercharging being intentionally held below standard, with a power output gain of approximately 15 %. It is however intended to discontinue supercharging of engines of such low rating, as a worth-while gain does not seem to be obtainable until the higher output ratings are reached.

313. *What arrangement do you prefer for the location and suspension of the diesel engine? Why?*

The motor equipment of railcars may be installed :

(*a*) in the body,
(*b*) suspended underneath the body, or
(*c*) on the bogie (projecting in part into the body).

The specific positioning of the engine, a question which has to be decided as early as at the designing and construction stage, depends to a very large extent on the general plan of arrangement, the size and power of the engine, and the choice of engine type and number; so far as the latter are concerned, the size of the engine will also be influenced by its speed.

All Administrations consulted, with the exception of the Swedish State Railways, use the underfloor engine with an engine rating of 240 HP and less. The upper output limit with this arrangement should at present be in the neighbourhood of 450 HP, a rate up to which suitable engines are now available.

TABLE 5*a*. — **SUMMARY OF ENGINE**

OWNER ADMINISTRATION ;		*BRITIS*
Type	horizontal 6-cyl.	horizontal 6-cyl.
Name of maker	British United Traction (AEC)	British United Traction (Leyland)
Nominal power (HP) at r.p.m.. 2-stroke/4-stroke horizontal/vertical/V-type	125/1 800 4/horizontal	140/2 000 4/horizontal
Mean effective pressure at full load (kg/cm²)	7.73	7.73
Average piston speed at nominal speed (m/sec.)	8.53	9.25
Type of supercharger	—	—
Pressure of air charge at full load (kg/cm²)	—	—
Gain in power output as compared with engine without supercharger (in p.c.)	—	—
Engine cooling system	water	water
Dissipation of heat of engine lubricating oil	air cooling system with special fan	air cooling system with special fan
Weight of engine (without lubricating oil) (kg)	850	897
Ratio weight/power (kg/HP)	6.8	6.4
Temperature of exhaust gases at full load and nominal speed at exhaust manifold flange (°C)	500 — 550	500 — 550
before entering turbo-compressor (°C)	—	—
Lubrication by oil with or without additives	with additives	with additives
Viscosity (SAE)	30	30
Special protective arrangements against	racing insufficient oil pressure	racing insufficient oil pressure insufficient water reserve
Type of regulation	fuel regulation	fuel regulation
Filters on engine	air, lubr. oil, fuel	air, lubr. oil, fuel

D IN DIESEL RAILCARS

LWAYS

horizontal 6-cyl.	horizontal 6-cyl.	vertical 4-cyl.	horizontal 6-cyl.	horizontal 6-cyl.
British United Traction (AEC)	Rolls-Royce	English Electric	Rolls-Royce	Davey Paxman
150/1 800 4/horizontal	180/1 800 4/horizontal	500/850 4/vertical	238/1 880 4/horizontal	450/1 500 4/horizontal
7.73	7.48	8.7	7.13	9.27
8.53	9.15	8.65	9.56	9.8
—	—	exhaust turbo-compres.	—	exhaust turbo-compres.
—	—	1.46	—	1.52
—	—	—	—	48
water	water	water	water	water
gine cooling water heat exchanger	engine cooling water heat exchanger	air cooling system with special fan	engine cooling water (heat exchanger)	air cooling system with special fan
850	1 120	6 868	1 425	2 662
5.67	6.22	13.7	5.98	
500 — 550	665	—	635	—
—	—	550	—	649
with additives	with additives	with additives	with additives	with additives
30	30	30	30	30
cing suffic. oil pressure suffic. water reserve	cavitation erosion racing insuffic. water reserve insuffic. oil pressure	racing insuffic. oil pressure insuffic. water reserve excessive water temper. insuffic. oil pressure at starting	cavitation erosion racing insuffic. oil pressure insuffic. water reserve excessive water temper.	racing excessive water temperature —
fuel regulation	fuel regulation	automatic power regulation	fuel regulation	combined speed and fuel regulation
lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel

TABLE 5*b*. — SUMMAR

OWNER ADMINISTRATION :		*GERMA*
Type	U 9 A with supercharger	U 9 A with supercharger
Name of maker	Büssing	Büssing
Nominal power (HP) at r.p.m.	130/1 800	150/1 800
2-stroke / 4-stroke horizontal/vertical/V-type	4/horizontal	4/horizontal
Mean effective pressure at full load (kg/cm²)	7.45	8.65
Average piston speed at nominal speed (m/sec.)	8.4	8.4
Type of supercharger	—	exhaust turbo-compressor
Pressure of air charge at full load (kg/cm²)	—	1.3
Gain in power output as compared with engine without supercharger (in p.c.)	—	15
Engine cooling system	water	water
Dissipation of heat of engine lubricating oil	—	—
Weight of engine (without lubricating oil) (kg)	765	815
Ratio weight/power (kg/HP)	5.88	5.44
Temperature of exhaust gases at full load and nominal speed at exhaust manifold flange (°C)	530	—
before entering turbo-compressor (°C)	—	590
Lubrication by oil with or without additives	with additives	with additives
Viscosity (SAE)	30	30
Special protective arrangements against	corrosion, insufficient oil pressure, excessive water temperature	
Type of regulation	fuel regulation	fuel regulation
Filters on engine	air, lubr. oil, fuel	air, lubr. oil, fuel

GINES USED IN RAILCARS

RAL RAILWAY

U 10	D 1548 MT	MD 650	MB 820 Bb	L 12 V/17,5/21 B
Büssing	MAN	Maybach	Daimler-Benz	MAN
150/1 900	210/2 000	1 100/1 500	1 100/1 500	1 000/1 500
4/horizontal	4/vertical	4/V-type	4/V-type	4/V-type
8.0	8.1	10.2	11.15	9.9
9.5	9.33	10	10.25	10.5
—	exhaust turbo-compres.	exhaust turbo-compres.	exhaust turbo-compres.	exhaust turbo-compres.
—	1.4	1.7	1.75	1.64
—	31	33.3	58.8	—
water	water	water	water	water
—	engine cooling water (heat exchanger)	heat exchanger with special radiator		heat exchanger with special radiator
940	1 100	4 600	2 800	3 600
6.22	5.24	4.18	2.54	3.6
600	—	—	—	—
—	600	600	650	620
ith additives	with additives	with additives	with additives	with additives
30	30	40	40	40
as for U 9 A	corrosion, racing, insuffic. oil pressure insuffic. water reserve excessive water temper.	corrosion, racing, cavitation, insuffic. oil pressure, excessive oil temperat., insuffic. water reserve, excessive water temper., insuffic. oil pressure at starting, insuffic. water temperature at starting		same as-for MD 650 and MB 820 Bb
el regulation	fuel regulation	speed regulation	speed regulation	speed regulation
lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel

TABLE 5c. — SUMM

OWNER ADMINISTRATIONS :	*Norwegian State Railways*		*Swedish Sta*
Type	DFXH — F	GTO 6	D 815
Name of maker	Hercules	Maybach-Motorenbau AG	Scania - Vabis
Nominal power (HP) at r.p.m.	204/1 800	650/1 400	205/1 800
2-stroke / 4-stroke horizontal/vertical/V-type	4/	4/V-type	4/
Mean effective pressure at full load (kg/cm²)	6.7	8.65	9.1
Average piston speed at nominal speed (m/sec.)	10.1	9.35	8.2
Type of supercharger	—	exh. turbo compr.	exh. turbo-compr
Pressure of air charge at full load (kg/cm²)	—	1.4	1.47
Gain in power output as compared with engine without supercharger (in p.c.)	—	no details	25
Engine cooling system	water	water	water
Dissipation of heat of engine lubricating oil	engine cooling water (heat exchanger)	engine cooling water (heat exchanger)	air cooling syste
Weight of engine (without lubricating oil) (kg)	1 475	3 250	1 020
Ratio weight/power (kg/HP)	7.23	5.0	4.97
Temperature of exhaust gases at full load and nominal speed at exhaust manifold flange (°C)	—	480	550
before entering turbo-compressor (°C)	—	—	—
Lubrication by oil with or without additives	with additives	with additives	with additives
Viscosity (SAE)	30	30	210 cSt 20°C (wint 400 cSt 20°C (sum
Special protective arrangements against	racing insuffic. oil pressure insufficient water reserve, excessive water temperature	corrosion, racing, insuff. oil pressure, exces. oil temperat., insuff. wat. reserve, exces. wat. temper., insuff. oil pressure at starting	racing insuff. oil pressu excessive water temperature
Type of regulation	speed regulation	speed regulation	combined speed and fuel regulatio
Filters on engine	air, fuel	air, lubr. oil, fuel	air, lubr. oil, fu

ENGINES USED IN RAILCARS

ways	*Irish Republic Railways*	*New Zealand Government Railways*	*Indian Government Railways*	
D 812	AEC Type A 215	Diesel 6-cyl. horizontal		
	AEC LTD Southall	Fiat 700.040	Fiat	Shinko
166/1 950	125/1 800	210/1 550	185/1 500	180/1 500
4/	4/	4/horizontal	—	—
6.8	6.7	—	—	6.38
8.8	4.75	—	—	8.0
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
water	water	water	water	water
ir cooling system	engine cooling water (heat exchanger) with special fan	engine cooling water heat exchanger	— —	— —
860	787	1 320	2 540	1 400
5.18	6.2	6.28	13.7	7.8
550	—	—	—	—
—	—	—	—	—
with additives	with additives	—	—	—
) cSt 20° C (winter) cSt 20°C (summer)	1 360 SECS (20° C)	—	—	—
cing suffic. oil pressure cessive water temp.	racing insufficient oil pressure	—	corrosion insufficient oil pressure	insufficient oil pressure
combined speed nd fuel regulation	fuel regulation	—	—	—
ir, lubr. oil, fuel	air, fuel	—	lubr. oil	lubr. oil

TABLE 5*d*. — SUMMAR

OWNER ADMINISTRATIONS :		*JAPANES*
Type	DS 21	DS 22
Name of maker	Hino	Hino
Nominal power (HP at r.p.m.)	60/1 200	75/1 700
2-stroke / 4-stroke horizontal/vertical/V-type	4/	4/
Mean effective pressure at full load (kg/cm²)	6.43	5.65
Average piston speed at nominal speed (m/sec.)	5.4	7.65
Type of supercharger	—	—
Pressure of air charge at full load (kg/cm²)	—	—
Gain in power output as compared with engine without supercharger (in p.c.)	—	—
Engine cooling system	water	water
Dissipation of heat of engine lubricating oil	not required	not required
Weight of engine (without lubricating oil) (kg)	820	800
Ratio weight/power (kg/HP)	13.7	10.7
Temperature of exhaust gases at full load and nominal speed at exhaust manifold (°C)	550	550
before entering turbo-compressor (°C)	—	—
Lubrication by oil with or without additives	with additives 9-11 cSt without additives 65.5 cSt (50 °C), 9.0 cSt (100 °C)	same as for DS 21
Viscosity (SAE)		
Special protective arrangements against	racing	racing
Type of regulation	fuel regulation	fuel regulation
Filters on engine	air, lubr. oil, fuel	air, lubr. oil, fuel

ENGINES USED IN RAILCARS

TIONAL RAILWAYS

DA 55	DMA 17	DMH 17 A	DMH 17 B
Hino	Shinko, Niigata and Daihatsu	Shinko, Niigata and Daihatsu	
100/1 700	150/1 500	150/1 500	160/1 500
4/	4/	4/	4/
4.9	5.29	5.29	5.65
9.08	8.0	8	8
—	—	—	—
—	—	—	—
—	—	—	—
water	water	water	water
not required	air cooling system with special fan	air cooling system with special fan	air cooling system with special fan
1 050	1 400	1 300	1 400
10.5	9.3	8.67	8.75
550	550	550	550
—	—	—	—
same as for DS 21	same as for DS 21	same as for DS 21	same as for DS 21
none	none	insufficient oil pressure	racing, insufficient oil pressure
combined speed and fuel regulation	combined speed and fuel regulation	combined speed and fuel regulation	fuel regulation
air, lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel	air, lubr. oil, fuel

The advantage of this arrangement as stated by the Railways of Great Britain, Japan and West Germany is that with the same train length more space can thus be reserved for the accommodation of passengers. The Railways of the Irish Republic, Norway, and Japan consider the ease of maintenance and removal with this arrangement a decided advantage.

So far as can be seen from available data, British Railways, the Railways of New Zealand, and the German Federal Railway utilise engines with horizontally arranged cylinders, this being the most suitable arrangement for underfloor positioning in view of the reduced space requirement in the vertical direction. Engines usually being suspended below the space reserved for passenger accommodations, a satisfactory and vibration-proof suspension and engine noise suppression are imperative.

The engines of long-haul fast diesel trains of the Norwegian State Railways and the German Federal Railway are positioned on the bogie, this permitting the utilisation of engines with vertical cylinders, either in line or with V-type cylinder banks, in particular with higher power ratings. Even with this arrangement, however, a limited saving of space should be possible. As the engine projects into the body, it is easily accessible from above.

The maximum power available in an engine installed on the bogie, known to the Reporter at present, is 1 100 HP. It is still too early to say whether or not the application of a still higher supercharging rate and cooling of supercharger air, by which means the output of the engine may further be raised, would result in a still greater power output available for railcar operation. It is probable, however, that a still greater power output is not needed.

The replacement of engines mounted in this manner may be effected either by means of a bogie drop stage or by lifting the body high enough to clear the engine. It is obvious that in this case the locally required installations represent a greater outlay of money.

By arranging the mechanical equipment in the forward section of the railcar, it is likely to be less difficult to protect space reserved for passenger accommodations against engine noise and vibration.

In the opinion of the German Federal Railway, it is preferable to install engines with a high power rating in a special engine room in the body. It facilitates the supervision of the proper function of the diesel engine and its auxiliary equipment by the train crew and increases accessibility. Moreover, the diesel engine and the auxiliary equipment are thus better protected against vibration, dirt and other injurious influences. The engine room can also be more adequately soundproofed and ventilated. The replacement of structural components must in this case be effected by lifting devices through a suitably provided opening in the roof.

The engine installation in the body is practised by British Railways in their railcar, type Southern Diesel-Electric, by the Swedish State Railways in their types YB06, YB07, YB05p and YF05p, and by the German Federal Railway in their multiple set VT 11.5.

314. *In the engine cooling circuits, do you use ordinary water, pure destilled water or water that has been treated in some way?*

If you use water that has been treated in some way, what products do you use in order to avoid the formation of scale and corrosion on the liners and motor block?

In general, the Administrations use ordinary water in the cooling circuits, to which Great Britain and Sweden (the latter in trailers) add an anti-freeze solution in winter.

The German Federal Railway adds anti-corrosion oils and scale stabilising agents (Calgon) developed to prevent the formation of scale. The Indian Railways add sodium bicarbonate as an anti-corrosion agent.

315. *In the light of your experience, what system of transmission do you stipulate according to the power of the railcar or, if the case arises, according to its category for a given power?*

What reasons can you give for your choice, taking into account the advantages and drawbacks of the various systems of transmission, mechanical, hydromechanical, hydraulic, and electric, from the point of view of: weight, size, ease of driving, efficiency, regularity of working, the passenger's comfort (reduction of noise and vibration), purchase price, and maintenance costs?

The transmission systems used by the railways in accordance with the power category of the railcar concerned may be seen in the following diagram.

It will be noted that mechanical, hydromechanical, or outright hydraulic systems are preferred, the upper limit of application of the purely mechanical transmission being at present slightly in excess of 200 HP, whilst the field of the high-powered railcars has been reserved to the hydraulic and hydromechanical transmissions, respectively. The electric transmission is represented in type Southern Diesel-Electric of British Railways and type KIHA 09 of the Japanese National Railways.

British Railways consider it premature to pass judgement on the relative merits of the various systems.

Reasons cited by the Administrations of Norway, Sweden, Japan, and West Germany for their preference of the mechanical and hydraulic transmission and combinations of the two, respectively, over the electric transmission are to the effect that the former are more advantageous in respect of weight and price. The Norwegian State Railways emphasize the fact that the efficiency of the hydraulic transmission is not inferior to that of other systems.

In low-power railcars the railways of Sweden, Great Britain, West Germany, and Japan utilise the mechanical transmission. It is easy to build and therefore less expensive, which is partly due to the fact that the whole transmission or certain component parts are easily obtained out of serial production in the motor vehicle industry.

The operating efficiency of the mechanical transmission, even under severe climatic conditions, as for instance in Norway, is stressed.

The Japanese National Railways, who in their railcar type KIHA 09 utilised the electric transmission, abandoned this type of transmission after a trial period, utilising now uniformly the hydraulic transmission in all railcars. A certain portion (50 %) of their railcars with electric transmission was refitted with the hydraulic transmission.

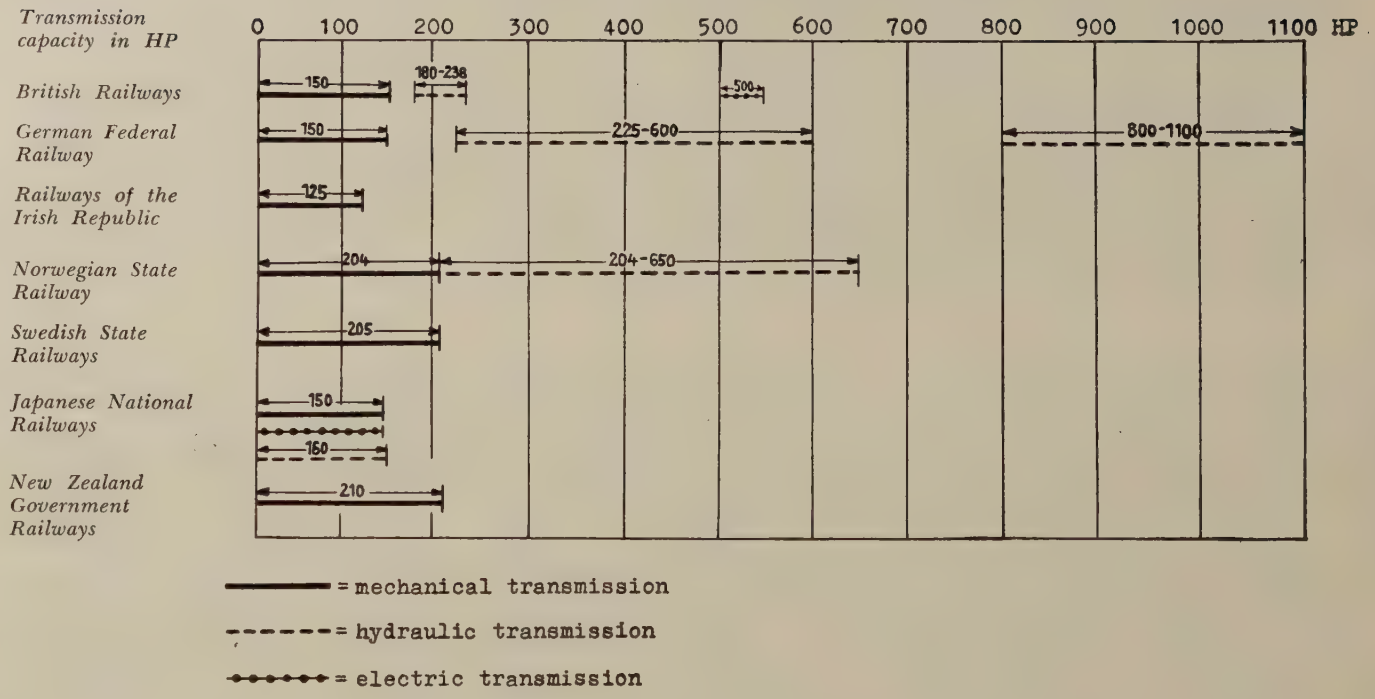
The Swedish State Railways mention the utilisation of a transmission, type Lysholm-Smith, i.e., a hydraulic transmission with a speed range from 0 to 40 km/h. At speeds in excess of 40 km/h, the engine crankshaft is connected directly to the driving axle. Considering that the acceleration at the lower speed range was unsatisfactory, the railcars are now being equipped with a hydraulic coupling and a mechanical 4-speed gearbox.

It is plain that a change has occurred in the appreciation of which is the best type of transmission to build into railcars, if we consider the development of opinion since the introduction of the railcar in railway operations up to the present. Approximately twenty years ago, Stroebe said in his report to the *International Railway Congress Association* in Paris in April 1937 that due to insufficient experience with hydraulic transmission systems a final decision on its relative merits should be withheld and that for the power range in excess of 200 HP the electric transmission is used as a rule, which has proved its reliability and is quite suitable to the application of remote control.

Perfectly functioning remote control systems are now available for all transmission systems.

Multiple-unit diesel trains with a hydromechanical transmission have been built in the last few years in the U.S.A. as well (e.g., the Xplorer, Train X and Dan'l-Webster).

Summary of transmission systems conditioned on power output.



32. Mechanical and hydraulic transmissions.

3201. *In the case of non-electric transmissions, what position do you stipulate for the various components of the transmission?*

In the body, under the body, on the bogies?

The Railways of the Irish Republic, Sweden, and Japan stipulate positioning of the transmission under the body; Great Britain, on the other hand, both in the body and under the body.

The Norwegian State Railways prefer installation of the transmission on the bogie in order to avoid excessive loading of the body.

The German Federal Railway utilises the installation of the transmission:

in the body,
under the body, and
on the bogie.

The choice of transmission positioning is probably decisively influenced by the positioning of the engine.

3202. *What arrangements do you prefer for driving the axles, in the light of your own experience (straight or conical gearing)?*

Both bevel and spur gears, straight toothed and spiral or helical toothed, are employed.

The German Federal Railway considers 500 HP the maximum power that can be transmitted to the individual axle.

When using bevel gears it is, in the light of the experience of the German Federal Railway, to be recommended to use them on the side of the higher r.p.m., i.e., on the side of the lower torsional moment.

3203. *Have you made any trials with light materials in the construction of the gear boxes? Have you met any difficulties in service due to the deformation of these boxes? If so which?*

None of the consulted Administrations has met with any difficulties in using light alloy gearboxes, so that there was no need for further trials.

The German Federal Railway alone states in this connection that mechanical and hydraulic transmissions of up to 360 HP, with gearbox and transmission housing, respectively, made of light alloy that have been in operation for more than 18 years, have never given any cause for complaint. On the other hand, for hydraulic transmissions with an output of 600 HP and more, transmission housings made of light alloy cannot be recommended for the reason that they show a slight tendency to distortion.

3204. *Have you studied any automatic gear change which is more silent, without interruption in the traction effort?*

British Railways have put into service as a trial an automatic change in an endeavour to simplify driving technique and obtain continuous traction.

The railways using the hydraulic transmission indicate that it is silent in operation in view of the fact that speed changes are effected exclusively by filling and emptying of hydraulic fluid circuits. Interruptions in traction effort whilst a speed change is made are scarcely noticeable, especially if filling and emptying operations of the circuits overlap.

3205. *Have you considered any simple safety device by which it becomes impossible for the diesel engine to run too fast on down gradients?*

Devices to prevent an overspeed of the engine are required only with mechanical or hydraulic transmissions with couplings, but not with transmissions with hydraulic converters.

British Railways and the Railways of the Irish Republic use a free-wheel device in the transmission, the Swedish State Railways employ a protective device that puts the gearbox out of mesh and stops the engine if the latter is overspeeding. The railcars

of the Japanese National Railways are provided with a neutral clutch, disengaging the engine from the wheels on down gradients, so that an overspeed of the engine, induced by the wheels, is not possible.

3206. *Have you looked into the design to find the simplest method of multiple control from one driving compartment?*

All Administrations, with the exception of that of the Swedish State Railways, state in their answer to this question that multiple control has been provided in their diesel railcars. Some amplify this statement to the effect that the system employed is very simple, whilst others indicate that continuous improvements are being made.

Although only one Administration specifically said so, it is probably correct to state that all Administrations generally provide for multiple control in new constructions if for no other reason than in order to enable them to increase capacity by the addition of a control trailer or, in case of fluctuating passenger demand, in order to allow two unit working with *one* driver only. It is especially on the personnel sector that the application of multiple control makes savings possible.

3207. *Have you carried out any research and comparative trials of different systems of transmission (such as trials with identical railcars, fitted with different transmissions) from the point of view of operating costs?*

Tests on this subject have been carried out by the Japanese National Railways only, i.e., railcars of identical design, experimentally equipped with either an electric or a hydraulic transmission, were tested in service from 1947 through 1948. Results obtained showed that the hydraulic transmission is more advantageous.

British Railways state that the question is under study at the moment.

3208. *Have you carried out any research concerning the relationship between the weight, the work done and the coefficient of user with different systems of transmission?*

No research of this nature was undertaken by the Administrations.

3209. *Have you made any trials aimed at a reduction in the weight of railcars to determine the relationship between life in service, the comfort in travel and the strength of materials as regards the weight?*

British Railways state that such trials will be undertaken at a later date.

The Japanese National Railways carried out tests with recently designed railcars to establish the relationship between stress and life in service and rigidity and frequency of proper vibrations as related to riding quality.

3210. *Have you made any trials of mechanical drive of the driving axles for axle loads of up to 20 metric tons to determine at what point it is desirable to reduce the non-suspended weight at high speeds?*

No such tests have yet been undertaken by any of the consulted Administrations.

British Railways have a very complete series of comparative trials in preparation.

The Norwegian State Railways consider it desirable to reduce the non-suspended weight to the minimum, for which reasons the reversing gears were mounted not on the driving axles but in the gearbox.

3211. *Do you stipulate that your railcars shall have a single driving compartment in the centre, or a driving compartment at each end, or a single driving compartment at one end?*

How do your conclusions on this point vary according to the category of the railcar?

Railcars with a driving compartment in

the centre do not exist with any of the consulted Administrations.

In respect of the other alternative, i.e., driving compartment at each end, or a single driving compartment at one end only, it will be noted that three different designs are in existence :

(*a*) railcars with a driving position at each end,

(*b*) railcars with a driving position at one end only,

(*c*) railcars with no driving position.

The advantage of the design under (*a*) is that the railcar may be used as an independent unit in either direction, a turnround not being necessary with change of direction. Great Britain, Norway, Sweden, Japan, and West Germany own railcars of this design.

Railcars may be provided with one driving position only as under (*b*), if the basic set consists of at least two units, i.e., either railcar plus railcar, or motor unit plus control trailer, which need never be separated in service. Railcars with this arrangement exist in the Irish Republic, Great Britain, Norway, Japan and West Germany.

Railcars without driving position as under (*c*) constructed after 1945 are in possession of the Japanese National Railways alone. They are interposed as re-enforcement between two railcars with a driving position at one end only.

The advantage of such an arrangement is that irrespective of number of units in a set the ratio « installed power/train weight to be moved » can be held unchanged.

33. Electric transmission.

331. *In the case of electric transmission, have you made any trials of new types of transmission with excitation of the traction motors and the generator in such a way as to be automatically adjusted to the speed of running?*

The Japanese National Railways state that manual weakfield control is used on traction motors of diesel-electric railcars.

With British Railways, automatic excitation adjustment is standard practice.

332. *Are you of the opinion that the traction motor should be rigidly fastened to the frame and that the transmission to the driving axle should be elastic, or do you consider nose suspension with rigid gears is sufficient?*

British Railways provide nose suspended motors on inter-city diesel trains operating at moderate speeds. Fully suspended motors are specified for trains operating at 90 m.p.h. (145 km/h).

The Japanese National Railways state that the traction motor is mounted on the bogie of high speed railcars, whilst the nose suspended motor is quite sufficient for railcars of comparatively low speeds.

The advantages and drawbacks of mounting the traction motor on the bogie and suspending it depend on the complexity of construction, the speed and weight of the traction motor, the influence on commutation, mechanical shocks, the effect on the rails, maintenance costs, etc.

333. *Have you carried out stability trials of vehicles during running and measured the forces between wheel and rail?*

1° *with nose-suspended motor,*

2° *with motor with elastic drive.*

What are the results of these trials and the methods of measurement used?

The Japanese National Railways have not conducted trials of this nature with diesel railcars, but have had occasion to carry out comparative trials with two types of electric railcars. Forces operative between wheel and rail and extent of vibration were measured. The inability, however, of obtaining perfectly identical conditions for comparison prevented them from reaching a conclusive decision. The Japanese National Railways tend, nevertheless, to the belief that the installation of the traction motor with an elastic drive above the spring should permit a

reduction of maintenance expenses for the traction motor and, incidentally, improve the action of the wheels against the rail by the reduction of the unsprung load.

British Railways state that such trials will commence shortly. Measurement will be by dynamic load measuring baseplates under the rails, inserted on selected lengths of track.

34. Body, bogies and their suspension.

341. *What types of structure, riveted, welded or mixed, and materials do you use for the construction of the body and bogies?*

The construction methods of the body and bogies vary, being adapted to the diversity of types and their purpose.

The Japanese National Railways still prefer construction from ordinary carbon steel profiles, whilst British Railways employ usual construction in ordinary steel, mixed steel/light alloy construction, and light-weight construction in ordinary steel.

The German Federal Railway predominantly uses light-weight steel construction and mixed steel/light alloy construction.

The Swedish State Railways use exclusively light-weight steel construction.

Light alloy for the construction of the body has been used by the Norwegian State Railways and the German Federal Railway.

Stainless steel is not used by any of the consulted Administrations.

Depending on the method of construction, hot rolled sections, cold shaped or rolled sections, welded sections, and pressed parts are used. Riveting, ordinary welding, and spot welding are used in the assembly.

342. *What design of suspension of the body on the bogies and the bogies on the axles do you think should be adopted in order to improve the running qualities of the railcars?*

Different types of suspension of the body on the bogies and the bogies on the axles are adopted. It may be surmised from the replies sent by the Administrations to the questionnaire that the tendency in more recent times has been towards the use of coiled springs with hydraulic shock absorbers or springs with rubber components in order to improve riding stability.

British Railways as well as the German Federal Railway call attention to the fact that choice of correct spring and vibration characteristics of all suspension components is a primary necessity, eliminating wear and tear between shopping periods to the greatest possible extent for considerations of maintenance and operating economy.

The Japanese National Railways are investigating at present the feasibility of adopting compressed air springs; similar tests have been initiated by the German Federal Railway.

35. Weight reduction.

351. *In the cases of railcars of standard construction, what values do you think are most suitable for the ratio « Installed power/weight to be moved » according to the characteristics of the system, type of service or category of railcar?*

(Cases of hilly or level lines, services at moderate or high speeds.)

In Table 6 a comparison has been made between values indicated by the Administrations as most desirable and those actually attained in standard sets (cf. Table 4).

The value « installed power/total weight of set » derived from data submitted is also indicated in Table 4. « Total weight of set » includes weight of passengers at a rate of 75 kg each, based on the number of seating accommodations available. The weight of passengers using standing room, luggage, and mail has not been considered.

The amount of this « power/weight » ratio determines the maximum speeds attainable in accordance with line conditions, this being also reflected in the values for gradients of 10 and 25 $^{0}/_{00}$, respectively,

quoted in Table 4. It will be noted, however, that in certain instances railcars of different types, but approximately identical « power/weight » ratio, show deviating values for attainable maximum speed. In some cases, the explanation of these deviations may be found in differences in movement resistance, the transmission ratio (interruption of tractive effort), and power consumption of auxiliary equipment.

Railways with standard sets consisting of railcar plus trailer or control trailer and desiring to improve the « power/weight » ratio, have the possibility of either to eliminate trailers or control trailers from sets or to improve the « motor unit/trailer or control trailer » ratio by adding one or more motor units (without trailers or control trailers).

This solution is made use of by the Swedish State Railways.

The Japanese National Railways intend to double the installed power in their standard railcars by mounting two engines of 160 HP each instead of one, thus improving the ratio « installed power/weight to be moved ».

Present plans of the German Federal Railway provide for a railcar for use in light main line and suburban service with a « power/weight » ratio of 10 HP/metric ton.

The most advantageous maximum value to an Administration in the construction of diesel railcars will also depend to a large extent on the geographic and traffic conditions prevailing in the country concerned.

Railcars to be used on lines with relative short stopping intervals, as for instance in suburban service, will require a high initial acceleration. Conditions are similar on lines in hilly country as regards climbing ability.

Railcars in long-haul service, travelling relatively long distances without intermediate stops, should, as a rule, not require a high initial acceleration, unless a frequent high initial acceleration is needed on account of a large number of reduced speed sections on the line.

TABLE 6. — **Summary showing the ratio « installed power/weight » to be moved (HP/ton).**

Country	Ratios recommended by the railways for use on lines				Actual ratios (*) of standard sets (HP/ton)
	in hilly country	in level country	for medium speeds	for high speeds	
Great Britain	8 (min)	6 (min)	6 (min)	8 (min)	4.2 to 9.8
Irish Republic	—	6	7	8 to 10	4.4
Japan	6 to 8	5 to 6	5 to 6	6 to 8	3.8 to 8.0
New Zealand	—	—	—	—	6.9
Norway			10		8.2 to 10.7
Sweden	8	—	6.3	8 to 11	4.4 to 4.7
West Germany	8	6 to 8	6	8	6.3 to 10.2

(*) Ratio as shown in Table 4.
« Installed power » for the calculation of the ratio is the rated power of the engine(s), without deduction of power consumed by auxiliary equipment, and « weight to be moved » is the service load of the standard set.

TABLE 7. — RAILCARS I

Railway Administration	Type	Basic unit consists of (*)	Built-in Power/ weight of set (service weight of standard set) (cf. Table 4) HP/tons	Overall length of railcar incl. buffers m	Weight of railcar excl. mechan. equipment and stores tons
Great Britain	Derby - Light - Alloy (Leyland)	M.U. + M.U.	9.76	18.5	25.0
	Derby - Light - Alloy (AEC)	M.U. + C.T.	6.15	18.5	23.99
	Metropolitan-Cammell (AEC)	M.U. + C.T.	5.17	18.5	26.61
Norway	Bmdo 86 f	M.U. + C.T.	8.2	21.5	24.54
	Type 88	M.U. + I.T. + M.U.	10.66	22.275	32.2
Sweden	YBo 6 YBo5p (narrow gauge 891 mm)	M.U. + T. + C.T. M.U. + T. + C.T.	4.44 4.7	17.55 16.96	14.4 10.3
Japan (standard types only were included)	KIHA 03	M.U.	6.0	10.9	8.246
	KIHA 06	M.U.	3.8	16.22	18.492
	KIHA 07	M.U.	4.86	19.72	22.371
	KIHA 09	M.U.	3.78	20.00	27.177
	KIHA 17	M.U.	4.52	20.00	25.020
	KIHA 51	M.U.	7.7	20.60	25.361
	KIHA 55	M.U.	7.96	21.30	26.031
West Germany	VT 08.5	M.U. + I.T. + C.T.	8.1 — 8.9	26.745	40.1
	VT 10.55	M.U. + 6 I.T. + M.U.	6.56	17.850	24.35
	VT 11.5	M.U. + 5 I.T. + M.U.	10.2	19.940	33.1
	VT 12.5	M.U. + I.T. + C.T.	8.1. — 8.9	27.145	38.316
	VT 95.9	M.U. + T.	6.25 — 6.94	13.298	11.07
	VT 98.9	M.U. + T. + C.T.	7.34	13.95	14.364

(*) Definition of abbreviations : M.U. = motor unit. — I.T. = inserted trailer. — T. = trailer. — C.T. = control trailer

IT-WEIGHT CONSTRUCTION

ight/ gth f car s/m	Overall length of trailer incl. buffers m	Weight of trailer excl. stores tons	Weight/ length of trailer tons/m	Overall length of control trailer incl. buffers m	Weight of control trailer excl. stores tons	Weight/ length of control trailer tons/m	Standard set		
							Overall length incl. buffers m	Weight excl. mechan. equipment and stores tons	Weight/ length tons/m
35	—	—	—	—	—	—	37	50	1.35
3	—	—	—	18.5	20.85	1.13	37	44.84	1.21
44	—	—	—	18.5	24.79	1.34	37	51.40	1.39
14	—	—	—	21.5	19.0	0.89	43	43.54	1.01
45	21.75	27.5	1.27	—	—	—	66.3	91.9	1.38
82 61	17.1 16.96	13.4 10.3	0.785 0.61	17.1 16.96	13.8 10.8	0.81 0.64	51.75 50.88	41.64 31.4	0.8 0.62
.75	—	—	—	—	—	—	10.9	8.246	0.75
.14	—	—	—	—	—	—	16.22	18.492	1.14
.13	—	—	—	—	—	—	19.72	22.371	1.13
.36	—	—	—	—	—	—	20.00	21.177	1.36
.25	—	—	—	—	—	—	20.00	25.020	1.25
.23	—	—	—	—	—	—	20.60	25.361	1.23
.24	—	—	—	—	—	—	21.30	26.031	1.24
.5	26.48	31.666	1.2	26.745	32.059	1.2	79.97	103.825	1.3
.36	12.20	10.57	0.87	—	—	—	108.9	112.0	1.04
.66	18.160	22.25	1.22	—	—	—	130.68	177.45	1.36
.41	26.78	29.486	1.11	26.895	29.541	1.1	80.22	97.343	1.21
.833	11.015	7.4	0.67	—	—	—	24.313	18.47	0.76
.03	13.95	9.85	0.76	13.95	10.0	0.716	41.85	34.21	0.82

352. *What object are you aiming at in weight reduction in the construction :*
— *reduction of the power installed;*
— *increase in the life of the engine equipment;*
— *better performance;*
— *reduction of the expenditures;*
— *other objectives, to be detailed ?*

The aim of all consulted Administrations is to increase the service life of the engine equipment by weight reduction, as a reduction of the weight to be moved will also reduce the strain to which the engine is subjected, provided that *identical* power is made the basis of such comparisons.

In view of the fact that a lower overall weight results in an increase of the specific power of the engine in relation to the weight of the vehicle, such a measure will lead to a better operating performance, as it will, for instance, be reflected in a higher initial acceleration. In addition, the reduced weight to be moved contributes towards a lower fuel consumption. This and the previously mentioned increased service life of the engine reduces expenditures and thus results in greater economy in railcar operations.

353. *In the light of your experience, what type of design and what materials do you stipulate for light weight construction ?*

In light weight steel construction of railcars, the component structural parts are joined to the greatest possible extent by welding.

A similar practice widely applied to the same end is the use of light metals and their alloys in conjunction with steel.

354. *What effect upon the running qualities have been noticed in the case of railcars of light construction ?*

None of the consulted railways, except the German Federal Railway, observed any ill effects of light construction upon the riding qualities of railcars.

The German Federal Railway states that bodies of a relatively light construction are more susceptible to interfering oscillations and the reactive effect of vibration dampers.

The Norwegian State Railways, in general and taking into consideration the prevailing conditions of the permanent way and occasional difficulties during the cold season, are satisfied with the riding qualities of their railcars of light construction. In order to improve the running qualities, vibration dampers have been inserted between the bogie bolster and the bogie frame.

355. *To what extent and in what parts of the railcar (suspended parts or not of the springs) do you consider weight reduction should be made ?*

British Railways hold that the weight should be reduced wherever possible, whilst the Norwegian State Railways do not consider it convenient further to reduce the weight of the bodies and bogies. Any possible additional weight reductions should apply to seats, walls, doors, etc. (possibly by the extended use of light alloys).

The Swedish State Railways support the view that the weight of non-suspended parts in particular should be reduced, citing as an example their use of suspended wheels of special type (SAB).

The Japanese National Railways build their railcars as light as possible, whereas the German Federal Railway believes that the weight reduction of its own railcars has already progressed considerably. In any case, expenditures incurred for weight reduction will have to be balanced against advantages obtained.

356. *What additional cost are you prepared to pay in order to reduce the total weight by 1 % ?*

The Swedish State Railways and the German Federal Railway would be willing to accept a moderately higher price; definite figures can, however, not be given.

All other Administrations are unable to take a position on this question, as pertinent data are not available.

357. *Amongst the railcars you described in the 2nd part of the questionnaire, which do you consider as being of light weight construction? Are you considering going still further in this direction?*

In Table 7 are listed the railcars, trailers, and control trailers considered by the Administrations as of light weight construction.

For each type the weight and overall length over buffers is given, on which two figures the ratio « weight/length » is based, i.e., separately for the motor unit, trailer, and control trailer of standard multiple sets and also for the complete set itself. The weight of the machinery and stores was *disregarded.*

The railways of Norway, Sweden, and West Germany intend to continue the development of light construction in their railcar building, but not to the detriment of travelling comfort.

As shown in the table, the values fluctuate between 0.75 and 1.39 metric tons per metre, the lower values applying to small units and the high values to medium and large units. The German Federal Railway considers it recommendable as well as feasible to lower the value for medium-sized and large railcars to one metric ton per metre by further promotion of light weight construction.

36. Sound insulation, heating, ventilation, air conditioning.

361. Sound insulation inside the vehicle (both as regards outside noise and the noise of the engine).

3611. *Do you consider it would be advisable to sound insulate (by insulation) all railcars and trailers in the future, no matter what their category?*

What are the recommended limits (intensity of noise in phons inside the vehicle for an outside noise of 110 phons at rail level under the vehicle)?

The Administrations consider sound insulation necessary, the Norwegian State Railways justifying a further improvement as in the best interest of passenger comfort.

The Japanese National Railways recommend an inside noise level of 70 phons.

The German Federal Railway recommends :

(*a*) 80 to 90 phons at driving positions and in compartments of short-haul services;
(*b*) 70 to 80 phons in compartments of long-distance services;
(*c*) 65 to 70 phons in luxury trains and sleeping berths.

3612. *According to your experience, what are the most effective and recommendable methods of sound insulation (by absorbing)?*

The most effective methods of sound insulation are :

(*a*) curbing of air propagated sound,
(*b*) absorption of air propagated sound,
(*c*) de-droning as a means to curb body propagated sound.

The methods applied to this end are :

(*a*) glass wool and in some instances double windows,
(*b*) perforated sound absorbing boards,
(*c*) sprayed materials, as for instance sprayed asbestos.

362. Reduction of noise due to the engines in the surrounding atmosphere.

3621. *What methods do you stipulate to reduce the noise caused by the engine equipment and especially by the exhaust?*

In general, silencers are provided to reduce the noise caused by the engine equipment and especially by the exhaust.

In some cases, engines operating with an exhaust-driven supercharger do not use a separate silencer, as the exhaust-type supercharger itself constitutes an efficient silencer. The Norwegian State Railways

observe that in their multiple-unit sets the engine equipment is so far removed from the passenger accommodations that a disturbance of passengers by engine noise may be considered as non-existent.

363. Heating and ventilation.

3631. *What methods of heating (hot water circuits, electric, etc.) and ventilation arrangements do you stipulate for the railcars and trailers according to their category?*

The most variable heating systems are used by the Administrations for their railcars, trailers, and control-trailers.

The Railways of the Irish Republic use steam for heating, generated in a boiler in the anteroom of the railcar.

The Norwegian State Railways equipped each unit of their fast multiple-unit sets with a hot water boiler, supplying hot water to the engines for starting.

The railways of Great Britain, West Germany, and Japan also use an air heating system with oil burner.

The railcars themselves are frequently heated by the waste heat of the engine cooling system, the cooling water either circulating directly through the radiators or heating the water in a separate heating circuit, or air, by heat exchangers, the warm air in the latter case being blown into the railcar by a ventilating system.

When using the waste heat of the engine cooling water for heating purposes in the passenger accommodations, an additional oil-burning heater is frequently inserted to preheat the car interior and the engine itself before going into service.

Hot air heating systems are frequently preferred by the Administrations for the reason that less time is required for preheating. An installation of this type may also be used in summer for the introduction of fresh air into the car interior, by-passing the heat source during the warm season.

The Japanese National Railways originally used the exhaust gases for heating, but as this system was found unsatisfactory, it was abandoned in favour of an oil-burning heating system.

British Railways use electric heating in their railcar with electric transmission, type Southern Diesel-Electric, whilst the German Federal Railway applies electric heating to (air-conditioned) equipment of type VT 10 and VT 11.

The ventilation of railcars, with the exception of those equipped with an air conditioning plant, is effected by opening the windows, fan ventilators in the roof driven by the slipstream, suction ventilators, and electrically driven ventilators.

3632. *In your opinion, what are the advantages and drawbacks of the various systems of heating and ventilation tried out on the railcars and trailers used on your railway?*

The Railways of the Irish Republic consider their steam heating system heavy and susceptible to failure.

The Norwegian State Railways use a hot water heating system with boiler in their railcars with hydraulic transmission, offering the advantage of permitting preheating the engine with hot water before starting.

The Japanese National Railways observe that an exhaust heating system, although inexpensive, is less reliable in operation, because its effectiveness depends on speed and load of the engine. Preheating of the car interior is impossible, and on sections on which the railcar may coast with stopped engine or engine under partial load, the heating system may function unsatisfactorily.

The Swedish State Railways, taking into account the prevailing climatic conditions in that country, consider their air heating system a suitable compromise.

The German Federal Railway lists as advantages of the hot water heating system: its great heat storing ability, low temperature of radiator surface, and practically no dust burning; its drawbacks are: sluggish regulation, and expensive antifreeze measures. The advantages of a fire-air heating system (without water) are: short time lag, low weight, simple servic-

ing of the heat transmitting system, no anti-freeze measures, and abundant fresh air supply. Its drawbacks are: heat storing inefficiency, stronger air currents and dust motion than with convection heating.

364. Air conditioning.

3641. *Taking into account the weight of the equipment, the consumption of power, the complication of the installations, etc., in what circumstances or within what limits do you consider air conditioning should be used on railcars and trailers?*

British Railways intend using air conditioning for fast inter-city units.

In the opinion of the Norwegian State Railways, the installation of air conditioning not only depends on the choice of the heating and cooling system, but also on the climate prevailing in the country concerned and the number of days in the course of the year, on which treatment of the air by air conditioning would seem necessary.

The Japanese National Railways intend to equip their railcars of the superior class with air conditioning. Tests are still being carried out to determine which system shall be adopted.

The German Federal Railway considers the installation of air conditioning recommendable in vehicles in which a higher standard of comfort is to be applied, the principal accommodations being: intercommunicating sets, railcars used in fast inter-city service over relatively long distances, as well as sleeping car and dining car units in sets.

3642. *What general conditions do you impose as regards air conditioning installations for railcars (difference of temperature between the inside and outside, degree of humidity, dust content, etc.)?*

The German Federal Railway only submitted a reply to this question as follows:

(*a*) the introduction of a minimum quantity of fresh air of 25 m^3 per hour per person, with all seats occupied;
(*b*) the heating capacity must be adequate to maintain an inside temperature of 20° C. above, if the outside temperature is 20° C. below and the vehicle, or set, is travelling at maximum speed;
(*c*) the cooling capacity must be adequate to maintain an inside temperature of 24° C. with a relative humidity of 40 to 60 %, with all seats occupied, if the outside temperature equals 32° C. with a relative humidity of 40 %;
(*d*) dust removal from the inside air must attain a minimum of 95 %.

3643. *If you think it advisable to use air conditioning, what system do you prefer?*

The German Federal Railway at present prefers high pressure air conditioning installations based on the « Jettair » principle (partly combined with electric heating).

3644. *To what extent, in your opinion, are the weight and cost of a railcar per passenger increased by air conditioning equipment, other conditions being equal? (To be given as a percentage of the weight and cost of the railcar without air conditioning.)*

The German Federal Railway states that the weight of a railcar per passenger is increased by the installation of air conditioning by approximately four per cent, whilst cost of a railcar per passenger will be raised by up to ten per cent, these figures being based on a multiple-unit set of Type VT 11.5 (Trans-European-Express).

37. Buffing and draw gear. — Intercommunication.

371. *What type of buffing and draw gear do you stipulate for the railcars and trailers on standard gauge and narrow gauge system?*

TABLE 8. — Summary showing operating costs per 1 000 km-axle for existing railcar services on a percentage basis.

	Great Britain	*West Germany*		*Irish Republic*	*Norway*		*Sweden*	*Japan*
		short-haul services (6 axles)	long-haul services (12 axles)		Bmdo 87f	type 88		
Sinking fund	30.8	23.0	17.5	9.5	13.5	19.3	17.0	22.0
Fuel	13.1	23.4	21.5	16.1	11.1	8.7	8.0	24.0
Staff	25.7	25.8	10.5	13.1	21.2	10.2	22.0	14.0
Maintenance and repairs	30.4	27.8	50.5	61.3	54.2	61.8	53.0	40.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Lateral buffers and central screw couplings, both usually of a lighter design than the standard type, as well as automatic centre couplers are stipulated by the Administrations. The latter are especially applied in services demanding a quick coupling and uncoupling of individual units or sets.

372. *In your opinion, what systems of intercommunication between vehicles should normally be provided (electric, compressed air, freedom of passengers to move from one coach to another) in a modern design of railcar?*

Pipes and circuits ensuring brake and power control and, according to the system applied, the proper function of the heating installation are considered indispensable by the Administrations.

In self-contained sets, gangways are provided by the Administrations, either in the shape of bellows or in that of a streamlined junction, permitting free intercommunication of passengers between the units of a self-contained set.

In some cases, gangways are also provided between the normally separate self-contained sets, coupled together and operated as a single set. When these gangways are enclosed by bellows, they may also be used by the passengers, whilst they are available to the train crew only, if no safety enclosure is provided.

4. OPERATING COSTS FOR RAILCARS.

41. *Please give the cost per 1 000 km-axle (in national currency and USA dollars) for your existing railcar services.*

Data made available by the Administrations are compiled in Table 8.

Conditioned by considerable differences in local operating conditions, the figures supplied by the Administrations diverge too much to permit the drawing of generally valid conclusions.

42. *To what extent will the measures you have outlined above make it possible to reduce the cost per 1 000 km-axle (to be given as a percentage, giving the heading under which a saving has been made)?*

The Administrations of the Irish Republic, Great Britain, Norway, and West Germany consider it too early to assess the effects of the various features upon overall costs.

The Swedish State Railways believe that it will be possible to reduce costs after the operating, maintenance and repair staff have become fully conversant with this equipment and as soon as damages incurred in the early stage of operations have been fully eliminated by constructive measures.

The Japanese National Railways state that the costs indicated in the reply to the preceding question may be reduced as follows:

sinking fund	by 1 %
fuel	by 1 %
maintenance and repair . .	by 4 %

III. SUMMARY.

1. The Administrations consider, it desirable to use railcars for operational, commercial, and economical reasons. The object of this measure is to improve facilities in passenger service, to hold and increase custom. To the extent that existing traffic requirements are approximately equal to the capacity of railcars and available reinforcement possibilities, the diesel railcar constitutes a very economical means of transportation.

2. Where temporary peaks in traffic must be accommodated, exceeding the normal capacity of the railcars, it may be advantageous to raise the frequency of low capacity trains instead of running engine-hauled high capacity trains, in view of the fact that comparable speeds of the railcars are generally higher and their turn-round time shorter, unless other types of passenger rolling stock are standing idle. This presupposes that the line capacity is adequate to absorb a larger number of low capacity trains.

3. In order to ensure a satisfactory adaptation to fluctuating passenger requirements, railcars should be designed in such a manner that reinforcement by a second motor unit, or a trailer, or a control trailer, is possible at all times, or that they can be built up into multiple-unit sets. This practice admits of an almost unlimited variability. In conformity with requirements, appropriate driving positions, control equipment, and, where necessary, gangways between individual units, must be provided; moreover, available engine power for traction must be adequate to ensure movement of the train in any of the possible compositions with a travelling speed sufficient to negotiate existing gradients on the line.

4. Desirable economies will be greatest, if the transportation programme of the Administrations in all fields of application permits the limitation of the necessary types of vehicles to the lowest possible number.

5. However, if traffic requirements demand the provision of several types, it is desirable to standardise structural components to the smallest possible number for reasons of economy.

6. Safety considerations in railcar operations may make it desirable to use two engines of correspondingly lower power instead of a single engine of higher power, irrespective of the fact that maintenance expenditures for a single engine are usually lower, because the amount paid for maintenance is determined by the number of cylinders rather than by their size.

7. At the present time, 4-stroke and high speed diesel engines are chiefly used

in railcars, being the type most readily available.

High speed diesel engines are preferable to those of low speed in diesel railcar construction for lack of available space and because they have a higher specific power output. The application of supercharging permits a considerable increase of power.

8. It is an advantage to install the engine underneath the body, if dimensions permit such practice, because the underfloor arrangement allows a greater passenger accommodation with equal body length. The engine is easily accessible for maintenance, and the engine and its auxiliary equipment can easily be exchanged. The upper limit with this arrangement may at the present time be assumed to be in the vicinity of 450 HP per engine.

   Larger engines, making an underfloor arrangement unfeasible, may be installed on the bogie; this arrangement, too, makes it possible to save space to a certain extent. The engine, in this case, projects into the body and is, therefore, easily accessible. The engine with the highest power rating known at present permitting an installation on the bogie with standard gauge railcars is one of 1 100 HP. (In these designs, the engine may be removed by using a bogie drop stage or by lifting the body sufficiently to clear the top of the engine equipment.)

   The installation of the engine equipment in a separate engine room in the body is recommended for high power engines as this arrangement will simplify control and accessibility. Furthermore, they are thus better protected against vibration, dirt and other detrimental influences. (The removal of the engine must, in this case, be effected through a suitably provided opening in the roof.)

9. The mechanical, hydromechanical, or fully hydraulic transmission is to be preferred to the electric transmission because of lower weight and a lower purchase price.

   The applicability of the fully mechanical transmission is limited at present to an output of slightly in excess of 200 HP, whilst the truly high outputs are reserved to hydraulic systems.

10. Mechanical and hydraulic transmissions may be mounted

    in the body,
    under the body, or
    on the bogie.

    It may be assumed that the choice of position of the transmission is strongly influenced by the chosen position of the engine.

11. Bevel as well as spur gears (straight and spiral or helical toothed) are used in axle drives.

    With bevel gears it is opportune to have them installed at the side of the higher r.p.m., i.e., of the smaller torque.

12. Gear cases cast from light alloys did not cause trouble with power outputs of up to 600 HP. For gear cases in excess of this range, the use of light alloys is less to be recommended, as housings cast from light alloys may be susceptible to distortion.

13. Experiments have been conducted with automatic gear changes in order to limit traction interruptions. If a hydraulic transmission is used, interruptions in the tractive effort are scarcely noticeable with speed changes, especially when filling and emptying operations of the circuits overlap.

14. Since in the case of using a mechanical or hydraulic transmission or coupling the engine may be forced to race when going down a decline, the insertion of a free-wheel or other protective device is to be recommended, disengaging the rigid connection between engine and driving axle, putting the gear box out of mesh, if need be, and reducing the engine speed.

15. Railcars are fairly generally provided with multiple control; this should invariably be embodied in new construction, because it permits running of two or more motor units coupled together with *one* driver only and thus allows savings on the personnel account.

16. Railcars to be used as self-contained units require a driving position at both ends, if it is desired to run them in either direction without a turn-round when changing direction.

On the other hand, railcars always used coupled to another motor unit a control trailer as a basic set require a driving position at one end only.

Railcars inserted as reinforcement between two other motor units do not need any driving position. The advantage of motor units of this design is that the ratio « installed power/weight to be moved » is always the same.

A single driving position may be raised to a higher level and it may also be located approximately in the centre of the vehicle.

It is a generally valid assumption that a turn-round of railcars to change the travelling direction is wholly unacceptable from an operational standpoint.

17. Fully suspended motors are to be recommended for rolling stock equipped with electric transmission and for high speeds, as it is thereby possible to reduce maintenance costs for the motors and the detrimental effects of the forces acting on the rails.

Nose-suspended motors are sufficient for lower speeds.

18. The riding qualities of railcars may be improved by the use of helical springs with hydraulic shock-absorbers or of springs embodying rubber components. Choice of the correct deflection and vibration properties of all suspension components is, however, at all times a primary consideration.

The engineering possibilities inherent in the use of compressed air springs deserve special mention.

19. Geographical and traffic conditions of the country concerned determine what maximum value should be assigned to the ratio « installed power/weight to be moved » in railcar construction. For use on lines in hilly country, a fast starting acceleration will be required. On the other hand, railcars or multiple-unit sets in long-distance traffic, with infrequent stops at long intervals, are not so much in need of a fast starting acceleration, unless particular conditions prevailing on the line concerned make a more frequent fast acceleration indispensable.

20. In new construction of railcars, the tare of vehicles should be reduced to the greatest possible extent by application of the light-weight construction method. Some of the advantages gained by this practice are listed below.

The lesser « weight to be moved » results in :

(*a*) a lesser strain on the traction engine equipment, which is, consequently, better protected,

(*b*) a reduced fuel consumption,

(*c*) a more favourable ratio « installed power/weight to be moved », which, in turn, leads to a better driving performance.

The long-term savings in the traction service made possible by a lower tare may justify a certain tolerance towards somewhat higher costs in the manufacturing process.

There is a diversity of opinion on the extent to which efforts towards weight reduction may be carried without seriously jeopardizing the riding qualities and, still more so, the safety of passengers in the event of accident. Under no circumstances, however, should any efforts in this direction result in a sensible loss of passenger comfort.

21. It is recommended to make all railcars and trailers less sensitive to disturbing noise in future by sound insulation measures and thus to improve passenger comfort. The driving positions in motor units should suitably be included in such measures.

    Approximate standards of sound insulation might be considered :

    80 to 90 phons for driving positions and passenger compartments in stopping trains;

    70 to 80 phons for passenger accommodations in long-distance trains;

    65 to 70 phons in luxury trains and sleeping berths.

    Particular attention should be paid to the reduction of the exhaust noise.

22. The most diversified systems are used to heat railcars, trailers, and control trailers.

    The various systems of steam heating, in which the steam is generated in boilers, cannot be recommended because of the weight of the installation.

    Likewise, heating systems based on the waste heat of the exhaust gases, have thus far failed to give satisfaction.

    Heating systems, in which the heat of the engine cooling water is utilized for heating purposes, may be desirable, if a supplementary heating system — for instance, oil burning — is embodied in the system, permitting heating of the engine cooling water to the desired temperature before starting the engine.

    Fire and air heating systems will preferably be used in trailers and control trailers, in which other heat sources, as for instance, engine cooling water, are not available.

    Electric heating systems are presumably of value only in railcars with electric transmission or in those in which a special current generating equipment is available.

23. Vehicles to which a higher standard of comfort applies should be equipped with an air conditioning system, if the additional expenditure is justified by higher revenues.

    Specific demands to be made on the air conditioning system from an engineering standpoint are determined by the climatic conditions prevailing in the country concerned.

24. Buffing and draw gear of light-weight construction may be utilized in railcars and multiple-unit sets.

    For services in which rapid coupling and de-coupling of self-contained units is required, it is recommended to use the automatic centre coupler.

25. Multiple-unit sets, which are permanently in service as self-contained sets, should invariably be equipped with gangways in order to facilitate free passage of passengers between component units. The provision of gangways between coupled motor units may also be avantageous, especially to enable savings to be effected in staff assignments.

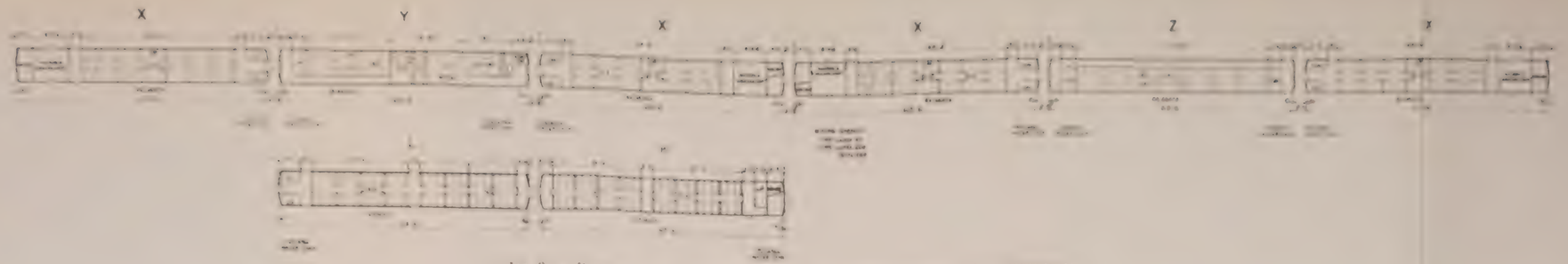
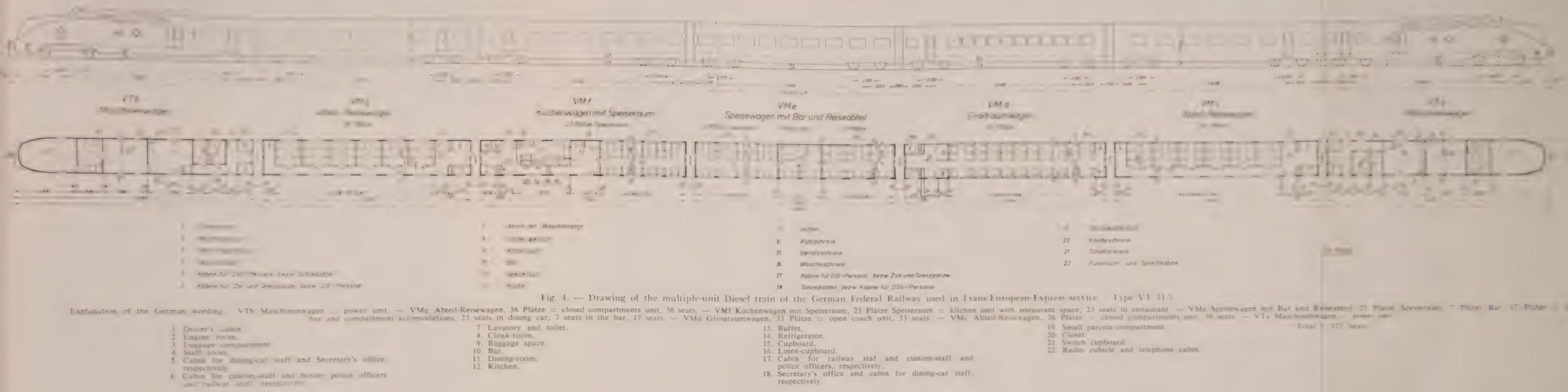


Fig. 2. — Drawing of the multiple-unit Diesel set of British Railways — Type SWINDON



Explanation of the German wording: VTb Maschinenwagen = power unit. — VMg Abteil-Reisewagen, 36 Plätze = closed compartments unit, 36 seats. — VMf Küchenwagen mit Speiseraum, 23 Plätze Speiseraum = kitchen unit with restaurant space, 23 seats in restaurant. — VMe Speisewagen mit Bar und Reiseabteil, 25 Plätze Speiseraum, 7 Plätze Bar, 17 Plätze bar and compartment accomodations, 23 seats in dining car, 7 seats in the bar, 17 seats. — VMd Grossraumwagen, 33 Plätze = open coach unit, 33 seats. — VMc Abteil-Reisewagen, 36 Platze = closed compartments unit, 36 seats. — VTa Maschinenwagen = power unit. Total 5 122 seats.

1. Driver's cabin.
2. Engine room.
3. Luggage compartment.
4. Staff toilet.
5. Cabin for dining-car staff and Secretary's office, respectively.
6. Cabin for custom-staff and border police officers and railway staff, respectively.
7. Lavatory and toilet.
8. Cloak-room.
9. Baggage space.
10. Bar.
11. Dining-room.
12. Kitchen.
13. Buffet.
14. Refrigerator.
15. Cupboard.
16. Linen-cupboard.
17. Cabin for railway staf and custom-staff and police officers, respectively.
18. Secretary's office and cabin for dining-car staff, respectively.
19. Small parcels compartment.
20. Closet.
21. Switch cupboard.
22. Radio cubicle and telephone cabin.

Fig. 4. — Drawing of the multiple-unit Diesel train of the German Federal Railway used in Trans-European-Express service. - Type VT 11.5

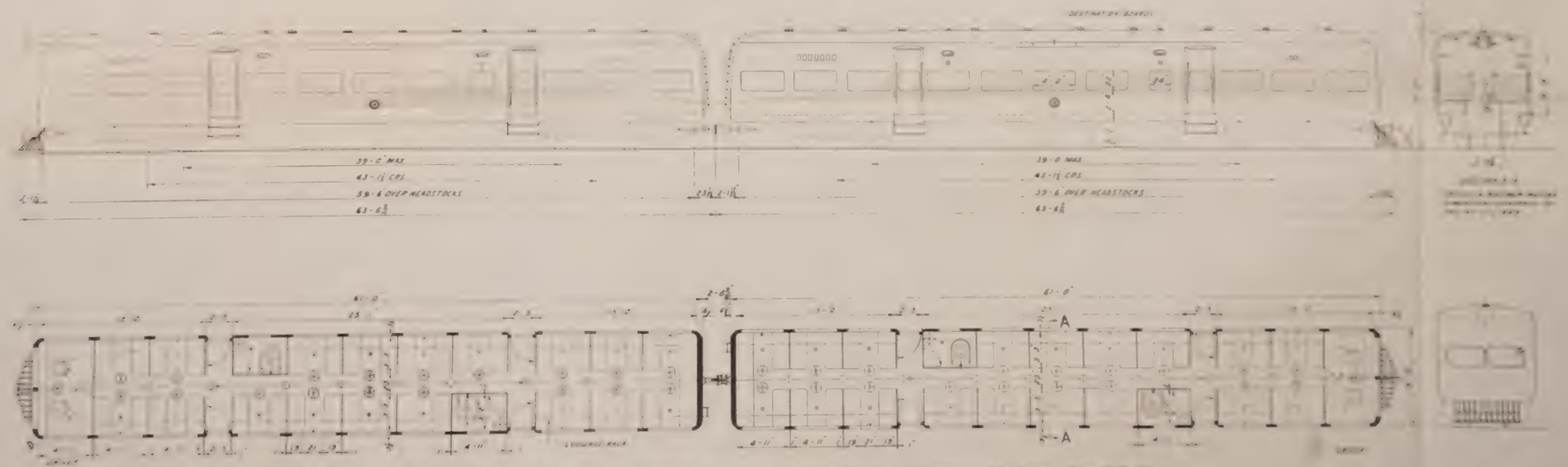


Fig. 5. — Drawing of the Diesel train of the Railway Board of the Indian Government Railways - Type CSC 1960

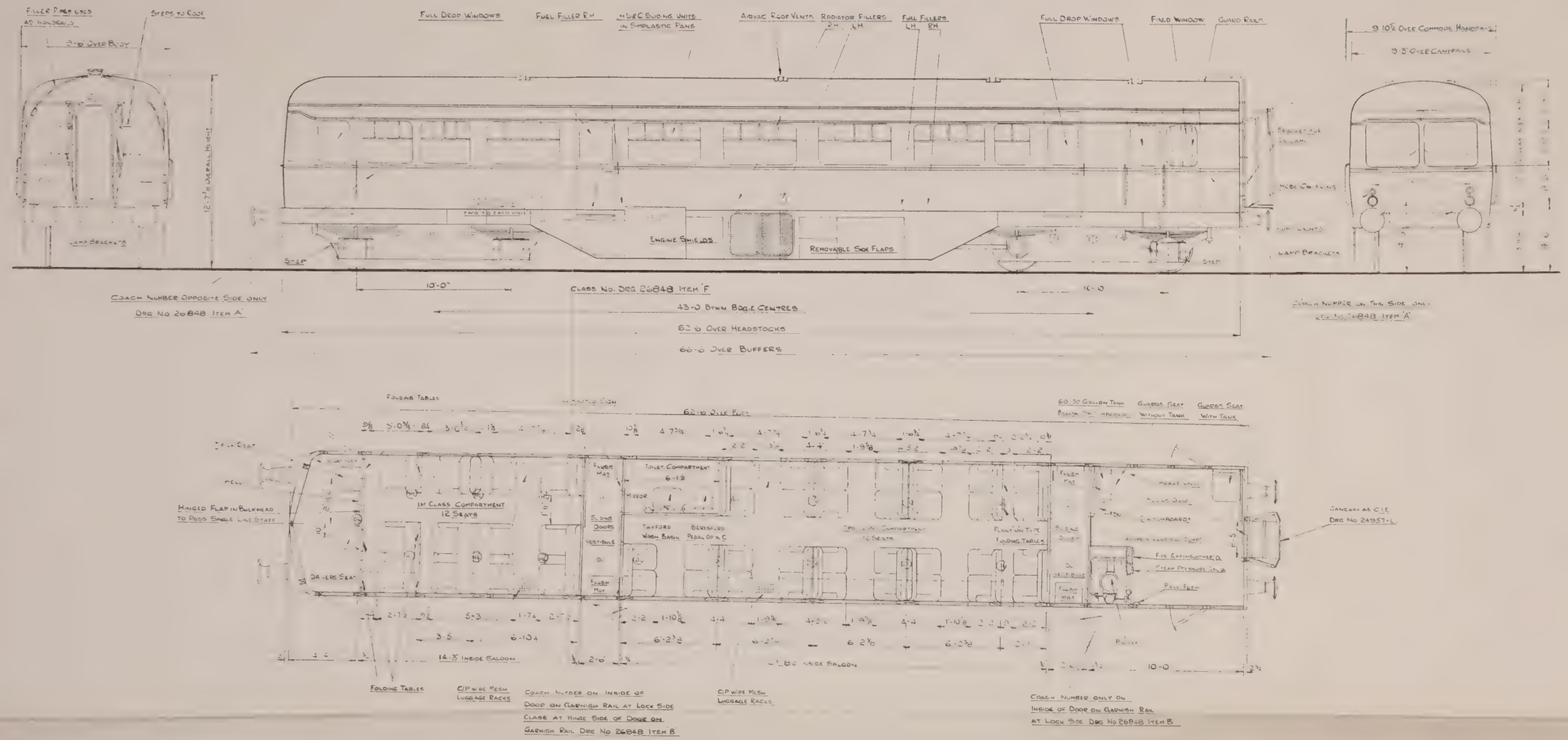

Filler Pipe Lkd as Handrail
Steps to Roof
2'-0 Over Body
12'-7¼ Overall Height
Lamp Bracket A
Full Drop Windows
Fuel Filler RH
H&BC Sliding Units in Simplastic Pans
Arvac Roof Vents
Radiator Fillers RH LH
Full Fillers LH RH
Full Drop Windows
Field Window
Guard Rail
9'10½ Over Commode Handrails
9'8" Over Cantrails
Two to Earth Units
Engine Smiths
Removable Side Flaps
Step
Lamp Brackets
10'-0"
10'-0"
Class No. Drg 26848 Item F
43'-0 Btwn Bogie Centres
62'-6 Over Headstocks
66'-6 Over Buffers
Coach Number Opposite Side only
Drg No 26848 Item A
Coach Number on this Side only
Drg No 26848 Item A
Folding Tables
Toilet Compartment 6-1.2
1st Class Compartment 12 Seats
Hinged Flap in Bulkhead to Pass Single Line Staff
Vestibule
Tilford Wash Basin
Berisford Pedal Op'n C
Plant on Type Folding Tables
Gangway as C.I.E. Drg No 24357-L
Fire Extinguisher
Steam Pressure Gauge
Feed Pipes
14'-3" Inside Saloon
C/P Wire Mesh Luggage Racks
Coach Number on Inside of Door on Garnish Rail at Lock Side Class at Hinge Side of Door on Garnish Rail Drg No 26848 Item B
C/P Wire Mesh Luggage Racks
Coach Number only on Inside of Door on Garnish Rail at Lock Side Drg No 26848 Item B

Fig. 6. — Drawing of the Diesel train of the Railways of the Irish Republic (Irish Transport Company). - Type IA-AI.

Fig. 1. — Motor Unit of the multiple unit Diesel of British Railway. Type Swindon.

Fig. 3. — Multiple-unit Diesel train of the German Federal Railway used in Trans-European-Express service. - Type VT 11.5.

Fig. 7. — Multiple-unit Diesel train of the Japanese National Railways. - Type KIHA 17.

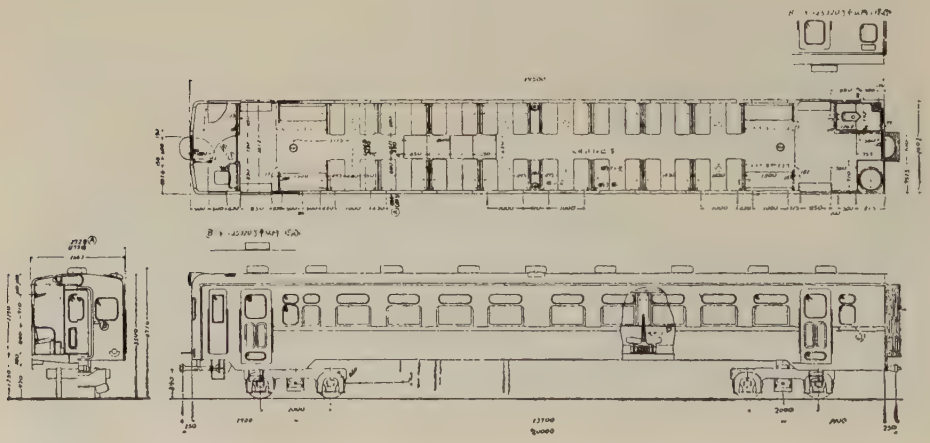


Fig. 8. — Drawing of the multiple-unit Diesel train of the Japanese National Railways. - Type KIHA 17.

Fig. 9. — Multiple-unit Diesel train of the Norwegian State Railways - Type 88.

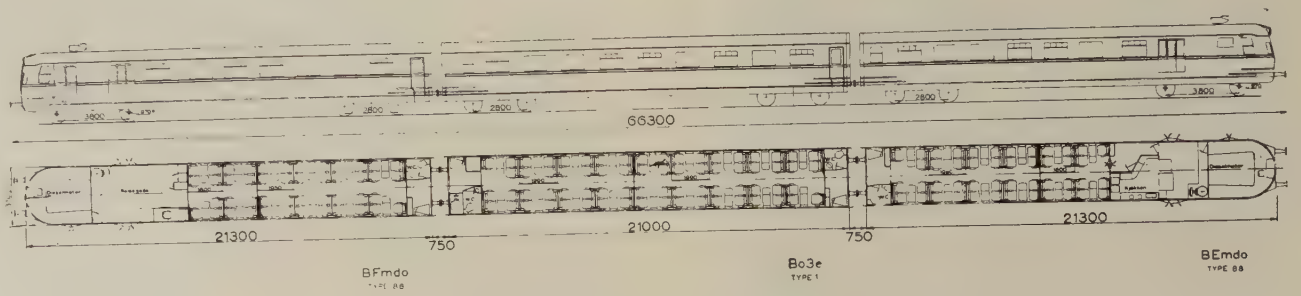


Fig. 10. — Drawing of the multiple-unit Diesel train of the Norwegian State Railways. - Type 88.

Fig. 11. — Multiple-unit Diesel train of the New-Zealand Government Railways. Type RM 100-34.

Fig. 12. — Diesel railcar of the Swedish State Railways. - Type YBo 6,

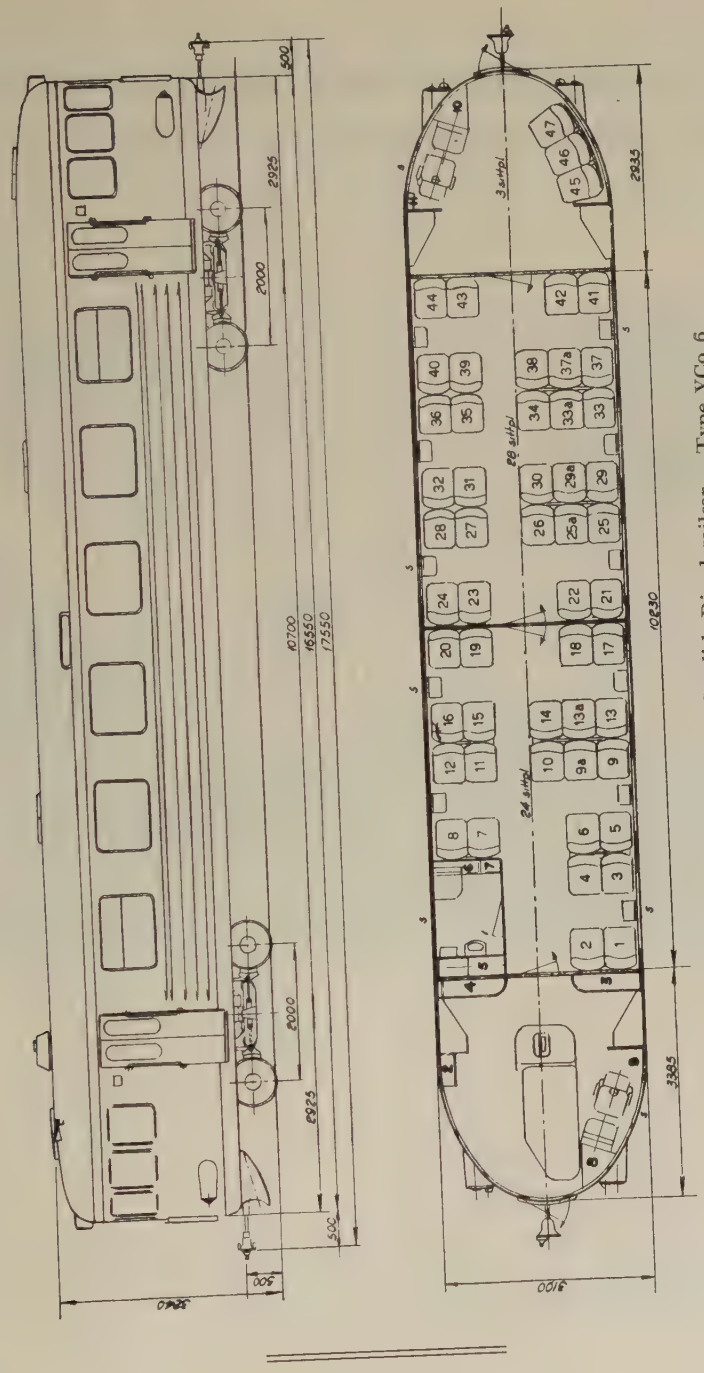


Fig. 13. — Drawing of the Swedish Diesel railcar. - Type YCo 6.

[625 .285 (43)]

Trans-Europ-Express trains and the contribution made thereto by the Deutsche Bundesbahn,

by Dr.-Eng. G. A. Gaebler

(*Die Bundesbahn*, No. 10, May 1957.)

In Germany, long distance passenger traffic by Diesel railcars has already a long history. The prewar fast services of the Deutsche Reichsbahn operated with powerful Diesel railcars with a running speed of 160 km (100 miles)/h are still remembered by all. These were pioneer applications, which were sensation making and which demonstrated the value and need to apply modern technics in the construction of rolling stock.

The D. B. immediately after the war embarked on a fresh investigation into appropriate vehicles as soon as it was given the opportunity to do so in conjunction with German Industry. In this way were designed and built the long distance railcars of the VT 08 series, which proved themselves to begin with inside Germany and then for some years since equally well in international service both from a technical and operating point of view. Apart from the electric motor coaches with pantograph of the D. B. built before the war to operate the Munich-Villach service from 1951 to 1953, the international service work-

ing by motor coaches was inaugurated in the timetable of 1953 with the Frankfurt/Main-Luxemburg (Montanexpress) and Hamburg-Zurich (Helvetia), services covered by D. B. stock like the Bar-le-Duc - Frankfurt s/Main by S. N. C. F. railcars. The following year when introducing the May 1954 service, the long distance traffic was extended by running D. B. railcars on the Dortmund-Paris (Paris-Ruhr) Dortmund-Ostend (Sapphire) and an equivalent rake technically speaking (VT 12) of 1st and 2nd class on the Hamburg-Copenhagen (Kobehavn Express). In order to make it possible to study the technical and operating problems of modern comfortable railcars, the German Federal Railways in addition have ordered and put into service two Diesel railcar test rakes, one a day set and the other a night train (1).

The experience obtained with these units (VT 10) has given very valuable information in connection with the work of designing them and for perfecting them for service and notably for the T. E. E. sets.

All this preliminary work as well as the earlier experience obtained with the running of Diesel railcars in international traffic have helped in part to bring other European Railway Administrations to consider the organisation of long distance international services by means of Diesel railcar sets.

The President of the Netherlands Railways (Mr. F. Q. den Hollander) personally gave a great impulse to this idea. In May 1954, on the occasion of the 8th Session of the Bureau of Common Matters of Interest (B. A. C.) at Bern, and during a discussion between the representatives of the European Ministers of Transport in Paris in July 1954, he defended the project to organise the Europ-Express services by Diesel railcars.

These conversations assumed a more precise form when the Europ-Express projects were again considered at Utrecht in September 1954. At this meeting, as regards the value of these long distance international services, as regards the design, acquisition, and operation of a stock of suitable modern vehicles, and as concerning the principal financial tariff and organisation questions, the ideas of the interested railway administrations were found to be in agreement.

In order to pursue the study of the technical, operating, and commercial questions still pending, three international Commissions were set up in November 1954. On the Technical Commission, the German Federal Railways were represented by the Author, on the Timetable Commission by Councillor Fischer, former Head of the Bundesbahn Headquarters Timetables Department, and on the Commercial Commission by Councillor Huber (President). The first meetings of the newly formed Commission, took place at the end of November 1954 at Genoa. The Swiss Federal Railways were given the presidency of the Technical Commission, Dr. Ing. h.c. Gerber, Head of the Traction & Workshops of the Swiss Federal Railways assuming the function of President. The French National Railways were represented by Mr. Tourneur, the Netherlands Railways by Mr. de Haas and the Italian State Railways by Mr. S. Cantutti.

In the following, we will only discuss the many and important non-technical questions discussed in common starting from the great Europ-Express Session, at Utrecht, on the 3rd November 1954, in so far as these influenced the technical projects and the design of the vehicles.

The meeting held on the 3rd November 1954 at Utrecht brought to notice a whole series of questions which required full investigation in the vehicle designing offices and also discussion at the level of the Technical Commission directed by Dr. Gerber. This is the case for example for the following questions, conditioned by the quality of comfort and service insisted upon, layout of passenger compartments, composition of staff for the train sets in

(1) Fröhne : « Gliedertriebzüge für Fernverkehr » (Long distance articulated railcar rakes). Die « Bundesbahn », 27, 1953, No. 12.

many ways unaccustomed to the work and their repercussions on the plan, requirements resulting from Customs Control during the journey, the question of equipping the rakes with heating equipment, ventilation, and ultimately air conditioning, as well as equipment for telecommunication by radio and telephone during the journey. To these has to be added the great number of technical questions affecting the design of the stock: radius of action, maximum and train journey speeds, minimum possible speed up gradient, reserve of power of the motors in normal service and in the event of damage to one motor, permissible stopping distance, allowed axle loading, minimum radius of curves to be run over, type and design of the couplings, possibility of running the sets in multiple units, including the possibility of tele-operation of several units without forgetting to observe the many arrangements laid down by U.I.C. (I.R.U.) and R. I. C. when these apply to railcars and their use on foreign lines.

These questions were discussed at the first meeting of the Technical Commission held at Genoa, at the end of November 1954. In addition to the Administrations already mentioned, the Belgian National Railways were represented by Mr. LEMAÎTRE.

These conversations led to a great degree of harmony between the views of the Railways represented on a whole series of questions of principle. It was agreed that the trains were to be designed *for a maximum speed of 140 km (87 miles)/h.* The *installed power* had to be adequate not only to be able to maintain this speed permanently but to attain it quickly and also up a gradient of 1.6 % even after stopping on it to operate at a speed of 70 km (43 miles)/h. Marked differences of opinion were expressed on the question of serving meals in a *separate dining car or at the passenger's seat.* As the opinions reflecting the habits in the different countries were so divergent, it was decided not to lay down any binding rule. This is why in the Trans-Europ-Express rakes now in service we find both separate restaurant sections and service at the passenger's seats. The discussions relative to the dimension to be adopted for passenger compartments and other places set aside *for their comfort,* for the luggage compartments, the service compartments for the Customs and train staff resulted in a large measure of agreement. In the same way as regards lighting, installation of *loud speakers, supply of electricity,* as also the *heating and ventilation* of the trains, it was found possible to agree to such an extent as to be able to supply to the Administrations, directives for the design of their units without however making them too restrictive.

Minimum requirements precisely stated and obligatory in application were drawn up and agreed on the stopping distances from 140 (87 miles), 120 (74 miles) and 100 km (62 miles)/h, the allowable axle loads, the minimum radius of curves to be taken, and the vehicle constructional gauge.

As rakes fitted with couplings with centre buffers may possibly be hauled at full speed by rakes fitted with the usual buffing and drawgear, the choice of couplings was left open.

In this way, and in broad lines, we had the directives for the *design and construction of the Trans-Europ-Express motor coach sets* but it was not found possible to get those present to agree sufficiently unanimously to make it possible to build the sets alike or even perfectly identical and uniform in conception. This is something to be regretted. A very complete uniformity as regards the technicalities and transport characteristics would certainly have been very desirable. It would also have been profitable as regards the Europ-Express idea. Provided we do not abandon *the search for units entirely uniform* for these long distance international relations, the method adopted may also have its advantages. Actually, all the Administrations concerned will learn to recognise from the services worked by prototype rakes their advantages and drawbacks which can and will be freely discussed later on. In this way, in a future relatively near, we shall be able to arrive at standard forms of

construction of a very high degree of perfection and based on very wide experience. In all these considerations, we must not overlook the legitimate interests of the European Industries concerned which by their experience and knowledge can contribute so much to the success of the proposal. The multitude of considerations to be taken into account in the proposal of international normalisation and standardisation became apparent in the endeavours to normalise a part of European Diesel locomotives since taken in hand at the U. I. C. by the O. R. E. (Office for Research and Tests) for all the European Railway Administrations. In spite of the willingness of all those concerned, it has not been found possible to eliminate the many local difficulties due to political economy to such a degree that we could at the present time put forward the results in the form of obligatory decisions for the Railway Administrations. But, as it was intended to operate services by Trans-Europ-Express rakes in the near future, the design work for this rolling stock was even then pressed for time, and an International Technical standardisation would have come up against unsurmountable difficulties in the extremely limited period available unless we purchased and placed at the disposition of all the members a single type of train composed of parts already proved in service.

Another meeting of the Technical Commission was held at Utrecht in the middle of February 1955. Its object was to make a joint examination of the directives with a view to future collaborations and to the exchange of information and experience already acquired.

The Netherlands Railways and the Swiss Federal Railways which had combined to build their Trans-Europ-Express rakes had already agreed to a large extent on the general scheme of the railcars. This agreement was confirmed by a specification discussed at the Technical Commission held at Bern, in May 1955.

In the case of the German rakes, it was not possible at that time to draw up a specification. It was only at the beginning of September 1955 that the Munich Headquarters Office, responsible for these designs, was told to proceed in conjunction with the German Industrial Firms with the design and detailed work of the rakes and given the necessary funds to do so. The documents of the dossier were brought together by a working party of the competent special Commission of the D. B. in October 1954. This is why the specification for the German rakes was only completed in December 1955.

As a result of this evolution, the Deutsche Bundesbahn found itself during the Winter of 1955-56 confronted by the obligation to press forward its design so as to complete it in a very short time. In February 1956, the work was sufficiently advanced for, after discussion of prices, contracts to be concluded with Mechanical Engineering firms. At this time started the most difficult part of the work : the joint design of the layouts adopted by the designing offices of the builders and the technical offices of the Munich Headquarters Office of the D. B. responsible for supervising the construction until they were free from defects, the determination, the calculation of the prices, and the ordering of the many accessories, from the motor unit to the installation of the heating, ventilation and air conditioning equipments, the draw and buffer gear, the details of the lighting equipment, the brakes, the running gear, and in addition the fixing of the delivery dates of the materials and details in accordance with the progress of the design and building.

At the end of the Summer of 1956, after delivery of the first supplies of materials, the first carriages were taken in hand in the shops. The first tests with the middle units of the new rakes began in mid-February 1957.

Technical study of the scheme.

The technical details of the rakes will be dealt with in articles by competent authors on the first unit going into ser-

vice (2). We will only indicate here the general lines based on experience acquired with the new long distance railcars built after the war, and amongst others with the articulated rakes built as test vehicles for the new T. E. E. trains.

The new Diesel railcars for the T. E. E. service should satisfy first and foremost all the following considerations :

1. *Safety.*

The safety of travelling by rail which is particularly good relatively to that by road or air should continue to be perfectly assured when travelling in the new fast railcars.

As the units of rail motor trains have to run in both directions at the same speed, the design was directed in such a way that in the event of collision which may occur in railway operation, for example at level crossings, at the two ends of motor coaches there should be structures of sufficient rigidity able to withstand considerable deformation and containing substantial weights of the power equipment. At the very end of the motor units the Diesel engines of 1 100 HP approximately, which weigh several tons, are fitted. The driving cab is raised and located behind the engines. In this way, the driver of the railcar is given greater security. Behind the driving cab are the auxiliaries, and behind these, the luggage compartments. The passengers are accommodated in the second part of the vehicle alone.

Light metals are largely used in the body structure (modulus of elasticity 1/3 to 1/4 that of steel) which has to stand the normal static buffing load of 150 t without deformation laid down for the large railcar rakes : this increases the ability to absorb a considerable amount of energy of deformation.

2. *Agreeableness of the journey.*

Besides safety, it is the agreeableness of rail travel which is the principal inducement to use the railway. Rail vehicles can provide a degree of comfort clearly superior to that of road or air travel without the operating costs and consequently the financial results being heavily burdened.

In the case of the T. E. E. services, which have to provide long distance transport of a particularly high quality it was necessary to offer the passengers as regards the spaciousness and upholstery of the seats something much more comfortable than that found in the ordinary express trains. Furthermore, the supplementary expenditure for installing air conditioning equipment was considered as not only justified, but as essential, in order to give the passengers in all weathers, accommodation agreeably controlled as regards temperature and remaining clean and free from dust.

As good riding, and, because of the great nervous fatigue of people today, protection against noise have to be considered as factors of the greatest importance to make the journey a pleasant one,

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(2) It is proposed to publish the following articles :

Eisenbahntechnische Rundschau (ETR) :

STROEBE, Dipl. Eng., President of Department of the D. B. « From the « Flying Hamburger » to the T. E. E. ».

GERBER, Dr. Eng. and J. T. KOSTER, Eng. : Diesel electric railcar rakes of the Dutch and Swiss Railways for international passenger service.

TASCHINGER, Dipl. Eng. : Principal characteristics of the design of the projected German T. E. E. rakes with particular regard to the use of light alloys.

MELANI, Dr. Eng. : The Italian stock of vehicles for the T. E. E. service.

Dr. LEICHER (German W.-L. Company) : Restaurant cars and kitchens of the T. E. E. rakes : ideas and operation.

Glasers Annalen :

SCHMÜCKER, Dipl. Eng. : Director of the D. B. Vehicles, running gear, sound deadening.

PFLUG, Dipl. Eng. and LETTAU, Dipl. Ing. : Motor installations and accessories.

BAUB, Dipl. Eng. : Heating, ventilation, air conditioning; other aids to comfort.

SCHUH, Dipl. Eng. : Architectural points of view in the construction of the T. E. E. rakes.

all possible imaginable and efficacious measures, in the light of today's knowledge, are taken in the construction of the running gear of the rakes as well as in the application of sound deadening materials in order to ensure the stability and good riding being at the highest level.

3. *Average or commercial train speed.*

The overall speed of the long distance European passenger trains at the present time is very high to the extent the state of the permanent way permits. The design of the T. E. E. railcars had to be such as to allow overall speeds at least as high and wherever possible higher still.

The extremely good ratio of motive power to weight of the rake (HP/t) in comparison with the normal long distance passenger trains as well as with existing long distance railcars not only made it possible to run them near the maximum speed of 140 km/h but in addition a higher speed up gradients over hilly lines and a very high rate of acceleration over all the speed range, thereby making it possible to get up to the high speed in a relatively short period after any speed reduction on the line. The normal unit of the German T. E. E. will have a specific power of nearly 10 HP/t. Figure 1 represents the gradient/speed diagram of the normal German T. E. E. unit with one or two motor units working and for comparison the corresponding curve for the VT 08 railcars.

4. *Reliability in operation.*

For the projected service over long distances at high speed and with practically no intermediate stops, the motors should have very high operating qualities.

The use of well tested and powerful motor equipments of the Diesel-hydraulic type in conjunction with an entirely automatic control of the motor units and the possibility of telecontrol according to the experience acquired with the older German long distance railcars (VT 08) equipped with identical power units gave every assurance of satisfactory service. The distance run without defects in 1956 had been raised with the VT 08 to the exceptionally high figure of over 150 000 km (93 000 miles) even though in many cases rakes had been run with only one motor unit. With the new rakes the use of two sets of motors of high enough power make it possible in case of any defect (fig. 1) to continue to run at high speed with one engine and so continue the journey without serious delays, at least on level line.

5. *Financial results.*

The new units must be economical or in other words they must be workable, even when partly loaded, thanks to their reduced working costs, without losing money.

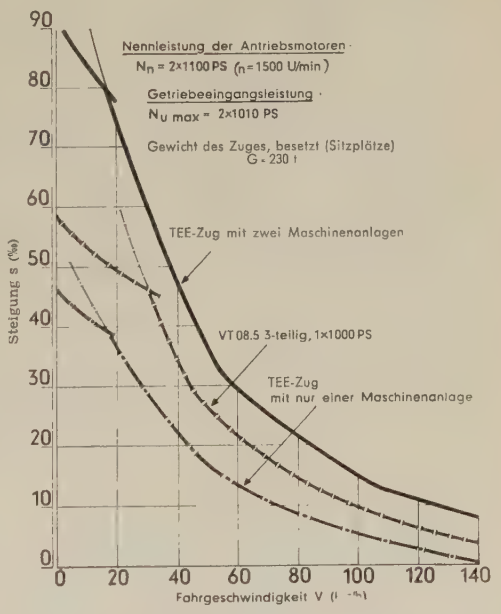


Fig. 1.

Explanation of German terms :

Steigung = down gradient. — Fahrgeschwindigkeit = running speed. — Nennleistung der Antriebsmotoren = nominal power of traction motors. — Getriebeeingangsleistung = power at entry to transmission. — Gewicht des Zuges... = weight of the rake occupied (seats). — T. E. E.-Zug mit zwei Maschinenanlage = T. E. E. rake with two power units. — T. E. E.-Zug mit nur einer Maschinenanlagen = T. E. E. rake with one power unit only. — 3-teilig = with 3 elements.

Trans-Europ-Express of the Deutsche Bundesbahn.

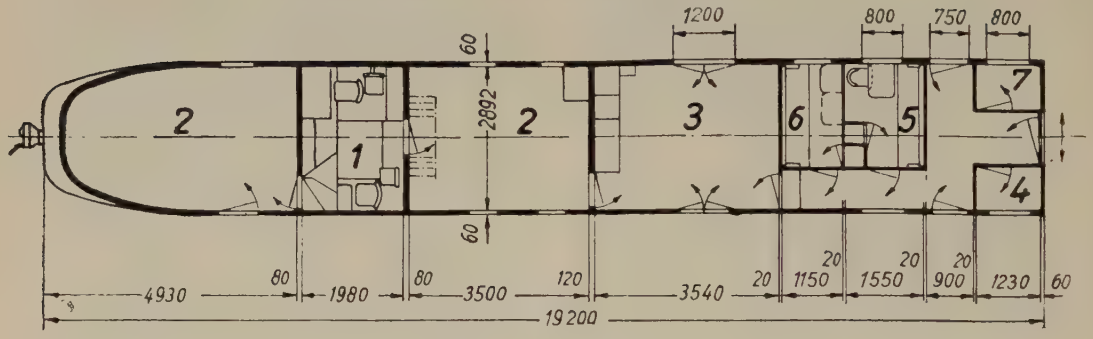


Fig. 2. — Motor coach.

1) Driving compartment.
2) Engine room.
3) Baggage section.
4) Staff toilet.
5) Compartment for W.-L. staff or office.
6) Compartment for Customs or Police or D.B. staff.
7) Radio compartment and telephone box.

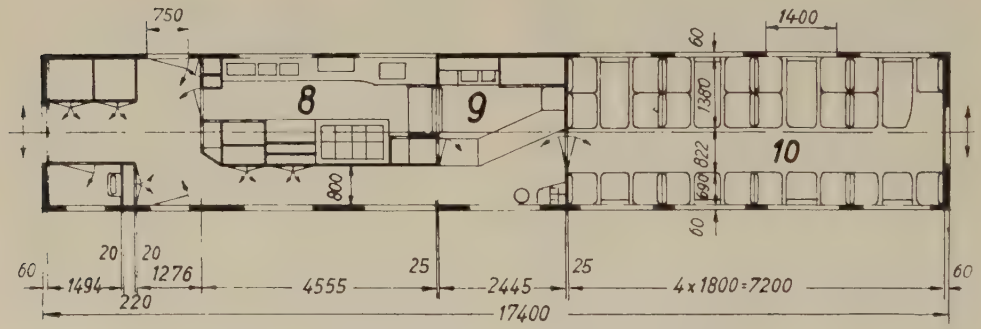


Fig. 3. — Kitchen-car with meals section to seat 23.

8) Kitchen. 9) Buffet. 10) Meals section.

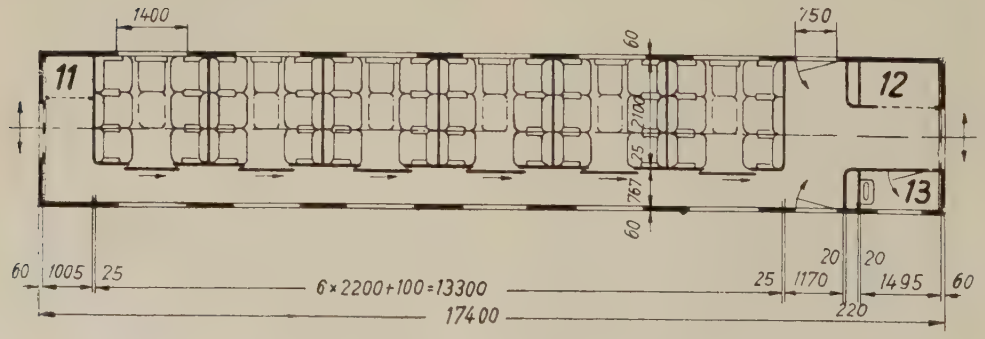


Fig. 4. — Car with separate compartments to seat 36.

11) Cloakroom. 12) Hand luggage. 13) W.C.-Toilets.

As regards capital expenditure, quite different criteria must be applied to these rakes than those used with local or regional units (3). The high daily mileages of these cars as compared with the older ones guarantee the amortization and interest charges in a definite way, even if the capital invested is considerable provided the motors work so well as to really allow these long daily runs and that these runs can be assured permanently without requiring too numerous a park of spare vehicles.

As far as it is humanly possible to judge, these conditions have been met. The operating costs of the units are here determined less by the capital charge that in particular by the wages of the staff and secondly by the costs of repairs and operating stores. The variation in the costs of long distance railcars in use up to the present allow us to hope to get with the new rakes favourable results, seeing that as we have stated the cost prices (DM/km-train) of the normal rakes of comparable capacity are always higher than those of the new rakes.

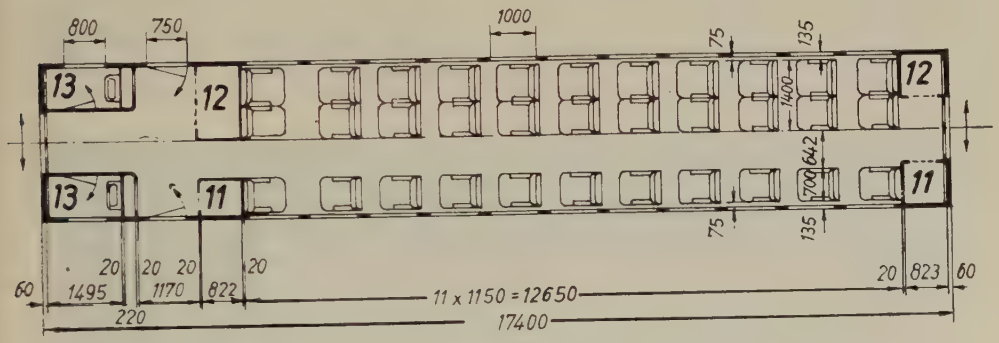


Fig. 5. — Car with large compartments. 33 places.

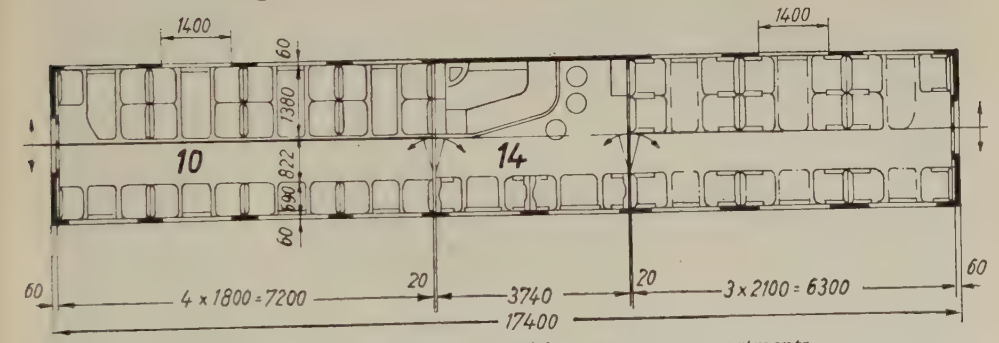


Fig. 6. — Restaurant-bar car with passenger compartments.
Meals section : 23 seats. Bar : 7 seats. 17 seats.
14) Bar.

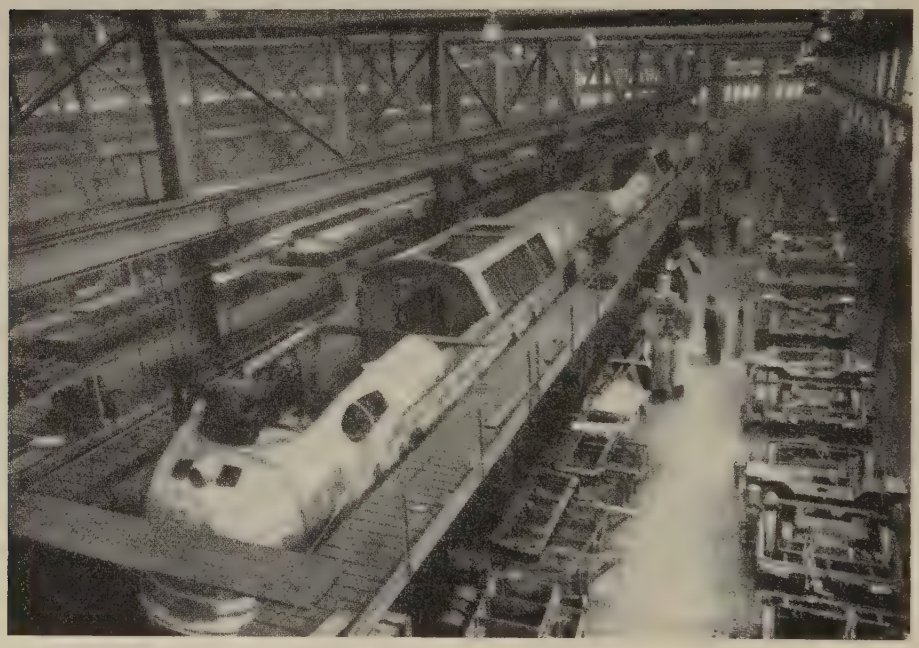
6. *Possibility of meeting traffic requirements.*

Experience has shown that the occupation of long distance passenger trains varies according to a seasonal cycle and that it can have considerable fluctuations at cer-

(3) GAEBLER : Long distance motor coach rakes and the competition of road vehicles and aircraft in passenger traffic over medium distances. « Die Bundesbahn », No. 24, December 1955.

tain periods of additional rushes of traffic as for example during great exhibitions.

In such cases, coupling together a number of units provide a remedy but because of the additional staff needed, it has disadvantages in particular as regards the service given. For this reason, the German T. E. E. railcars have been designed so that without difficulty and very quickly several units can be coupled together but also take out intermediate vehicles in service. The rake can in this way be one of 6 or up to 12 vehicles.



T. E. E. railcar under construction.

7. *Adaptability to the tastes of the passengers.*

The desiderata of passengers as regards the installation of the stock and the services given them differ frequently. This has to be kept in mind in the scheme.

The D. B. rakes are formed with the motor units at the ends (fig. 2) with a kitchen car with dining compartment (fig. 3) and with intermediate vehicles of various arrangements. These middle units are :

a) coaches with separate compartments and side corridor (fig. 4);

b) coaches with long open compartments with adjustable and revolving seats allowing the passenger to recline (fig. 5);

c) restaurant cars with dining section and bar and with one large compartment (fig. 6), which can also be used for small parties of passengers.

In this way, it will be possible to meet local desires and needs, often differing, of the travelling public by making up the rake in a suitable way.

As the motor and passenger vehicles are separate the latter are screened from all effects of the motor unit.

Thanks to the use of a kitchen car

and dining section and a restaurant car, which generally is attached to it, the capacity of the restaurant car can be adjusted in a large measure to the needs probably different in the various train services.

8. *Possibility of betterment.*

When designing the rakes, it had to be kept in mind that if the experiment was successful it could become necessary to make wide use of elements of these rakes even for long distance runs of a different kind. For this reason, we kept in mind the possibility of improving them in the following directions :

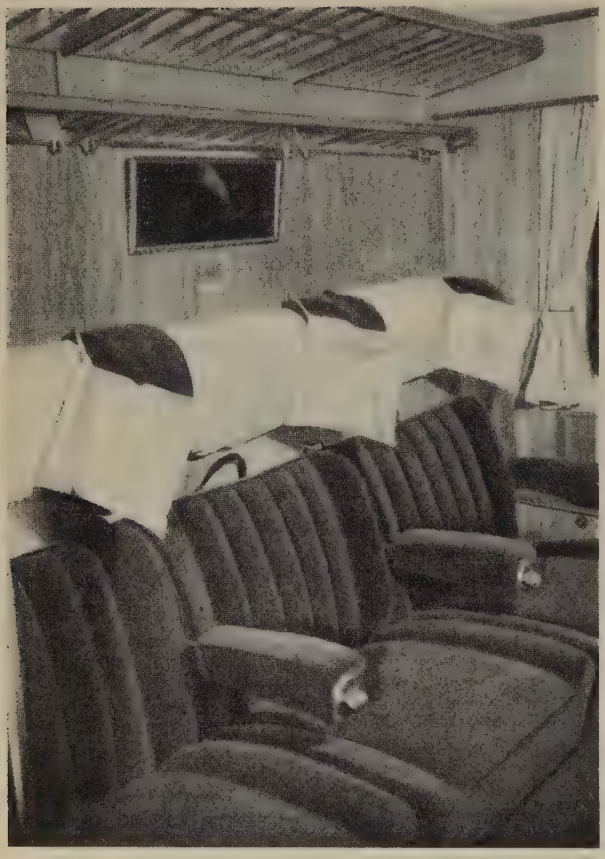
a) units with sleeping berths or sleeping cars can without technical difficulty be added in addition or replacement of the central unit with side corridors or with adjustable seats. These units can be built too in such a way that if running over main lines, partly by day and partly by night, they can be either day coaches or by a simple change be made into sleeping cars;

b) as a result of separating the « carriage-kitchen-meals section » from the « restaurant car », the first can be used by itself in a train working on which the demand for full meals is small;

c) through the ease with which the end units with their propulsion motors can be detached, it is possible to replace the Diesel-hydraulic motor units from one or both ends by electric motor coaches should it be necessary. It thus becomes possible to use for the T. E. E. services the cheap electric current more and more available in Europe with the progress of electrification, seeing that it is possible to build motor vehicles able to use all currents, that is to say, motor vehicles functioning with D. C. of 1 500 and 3 000 V and A. C. 16 2/3 and 50 Hz;

d) to still further improve steadiness of running and good riding, improvements in the construction of running

Interior of large compartment car of the Deutsche Bundesbahn T. E. E. rake.



Interior of the car with separate compartments of the Deutsche Bundesbahn T. E. E. rake.

gear and springs can be envisaged. With the new vehicles going into service the running trials with bogies with pneumatic springs and anti-rolling devices have been begun. As soon as the trials have given good results, which may be taken as durable, the modification of the bogie will be taken in hand; these are now fitted with the traditional steel springs but the designs have been prepared for such a future change.

Starting from the Summer 1957 service, the T. E. E. rakes cover the fast European day services. The new German units were put into service during the Summer, set by set, on the trains operated by the Deutsche Bundesbahn. In design and equipment, these rakes more than satisfy not only German ideas as to comfort, safety and speed to be provided on the main railway services but also in the most complete way, the views of the Managers of the interested European Railway Administrations as sketched in by the President Mr. DEN HOLLANDER (4).

The German Federal Railways hope that their rail motor coach rakes will meet with every success in Europe both with regard to those of other participating European Administrations and also in the keen competition with the other means of transport, road and air.

(4) Safety and comfort, major trumps of the Railways in the competition for passenger traffic. « Bulletin of the O. R. E. of the U. I. C. (I. R. U.) », No. 3, December 1955.

[625 .13 (42)]

Cellular embankment

(*The Engineer*, September 6, 1957.

Subsidence caused by brine pumping has been experienced at the Elton viaduct, which is between Crewe and Sandbach, on the main line to Manchester, of the London Midland Region of British Railways, since it was constructed in 1842. Between 1892 and 1956 a total subsidence of about 16 ft. was recorded, fluctuating from 2 in. to 9 in. in a year, the yearly average being 8 in. It is thought that subsidence of this kind will continue indefinitely.

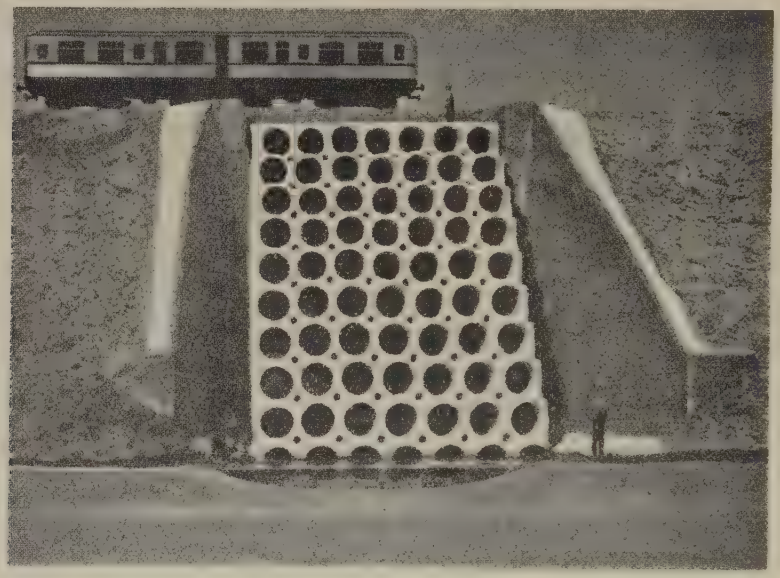
Existing bridge at Elton, showing steel and timber strutting.

The first of our illustrations depicts a steel bridge crossing a stream at Elton, and shows the strutting which had eventually to be added after successive heightenings. Since the structure is tilting slightly, as well as sinking, it was considered that successive heightenings of the bridge had been carried on practically to the limit, and with the advent of electrification, with overhead gear on the line, a more amenable solution was sought.

The resulting design is shown in the second illustration, which is an impression of a model. The cellular construction shown will consist of a number of reinforced concrete pipes, each with an external diameter of 5 ft, curtailed in total length in the higher positions so that the outline of the embankment is approximately followed. The lowest pipes will rest on a reinforced concrete raft, and all the pipes are to be concreted together and reinforced,

since it is intended that the block thus formed will behave monolithically. As the block sinks it is intended to add more pipes at the top, and to lengthen the lower ones so that they will still extend across the full width of the embankment. Thus, however far settlement continues, there will still be passage for the stream. On each occasion when such rebuilding is necessary, the permanent way will be reinstated over the top in a conventional manner.

The ground conditions at this site are poor, and the new structure will permit some lowering of loading under the existing brick walls. But the main idea behind the design, we understand, is to accommodate conveniently the adjustments necessary because of perpetual subsidence.



Model of proposed cellular structure which will replace the bridge, and will be heightened as subsidence occurs.

[625 .251 (42)]

Improved type of driver's brake valve,

fitted to E. P. brake controllers on London Transport rolling stock.

With a view to minimising the maintenance of electro-pneumatic brake controllers on London Transport rolling stock, three such controllers have been fitted experimentally with poppet valve driver's brake valves and, after a year in service, have been found to be in perfect working order.

The standard rotary valve requires regular lubrication and skilled maintenance, as its face must have a perfectly smooth finish. On the three experimental controllers the rotary valve has been replaced by four cam-operated poppet valves, which have been so arranged that the brake handle positions are identical with those of the standard controller.

As may be seen from the drawing, the port plate casting houses four rubber seated poppet valves mounted vertically; these are held upwards to their seats by spring pressure and the valve stems, which project from the air chamber of the casting, are sealed by synthetic rubber « O » rings. Operation of the valves is through rockers, fitted at the free end with rollers, by a circular face-cam plate mounted above the valves and attached to the driver's brake valve spindle. If it is necessary to remove the valves, they are accessible from the under side of the port plate casting.

The sequence of valve operations, through the driver's brake controller handle, is as follows:—

Position I (Release and
Position II (Full E.P.)
Valves « A » and « B » closed, valves « C » and « D » open, allowing air from the main reservoir to pass to the equalising reservoir and train line pipe.

Position III (Lap)
All valves closed.

Position IV (Pneumatic Service Application)
Valves « B », « C » and « D » closed, valve « A » open, exhausting air from the equalising reservoir via a choke.

Position V (Emergency Application)
Valves « C » and « D » closed, valves « A » and « B » open, exhausting air from the equalising reservoir and train line pipe.

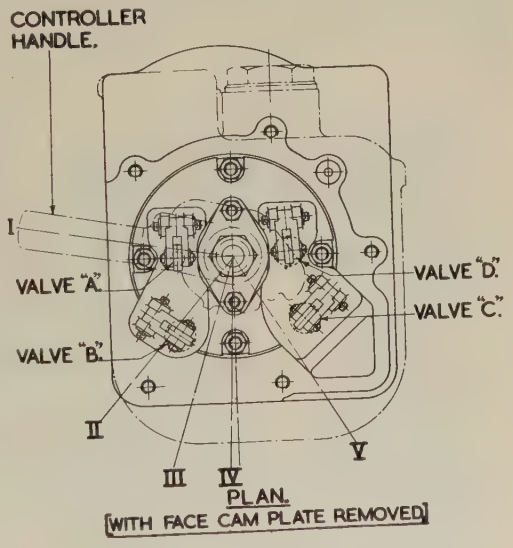


Fig. 1.

During the year in which the three experimental brake valves have been in service, it has not been found necessary to carry out maintenance on any of them, and the wear on moving parts has been negligible.

The poppet valve driver's brake controller has been developed by the Westinghouse Brake & Signal Co. Ltd. to the

requirements of Mr. A. W. Manser, Chief Mechanical Engineer (Railways) of London Transport. The three modified controllers are fitted in three different types of rolling stock; one each in a « P » stock car (Circle Line), an « R » stock car (District Line) and a « 1938 » Tube stock car (Piccadilly Line).

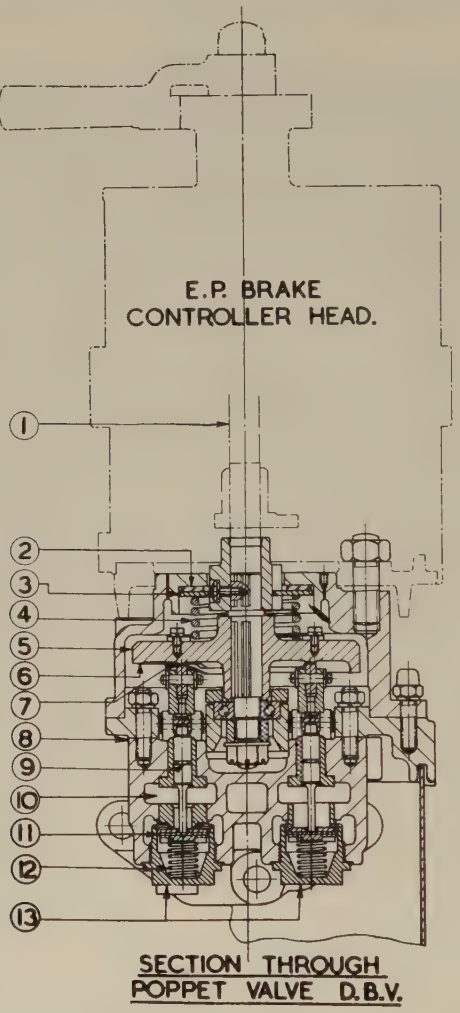


Fig. 2.

1. Driver's brake valve spindle.
2. Friction washer.
3. Friction plate.
4. Friction plate spring.
5. Face-cam plate.
6. Outer cam (Controlling valves « B » and « C »).
7. Inner cam (Controlling valves « A » and « D »).
8. Port plate casting.
9. Rubber « O » ring.
10. Air chamber.
11. Rubber seated valve.
12. Valve spring.
13. Valve caps.

[656 .25 (42)]

Passenger train staff intercommunication.

Development of equipment for Southern Region electric and diesel-electric sets.

(From *The Railway Gazette*, September 27, 1957.)

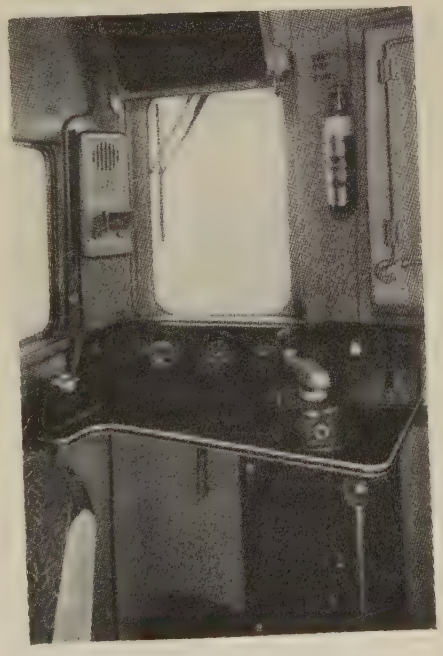
The provision of facilities to allow communication between driver and guard of a train while in motion has engaged the attention of railway engineers for a considerable number of years. One early system was developed by William Stroudley, Locomotive & Carriage Superintendent of the L.B.S.C.R., some 80 years ago, which used battery-operated bells by means of which driver and guard could exchange code signals when slipping coaches or in an emergency: this came into quite general use on the then L.B.S.C.R. and persisted until at least the first world war.

Equipment to allow two-way oral communication was developed in 1929 and fitted to a large proportion of the electric stock of the then London Underground and subsequently to the Waterloo & City trains of the former Southern Railway under the trade name Loudaphone.

Regular tests.

In the case of what are now Southern Region electric trains, their regular operation involves tests both of a routine and emergency nature which require the co-operation of the two members of the train crew, that is, driver and guard. To facilitate this, and to permit a closer operational association generally, the Region has decided that Loudaphone intercommunication shall be provided on its future electric and diesel-electric stock after successful running tests had been carried out. The first to be provided with these facilities are the diesel-electric multiple-unit trains now running between London and Hastings via Tunbridge Wells.

It was desired to employ the « duplex » system, whereby both instruments can operate simultaneously, and after development work by engineers of the Region with the co-operation of Clifford & Snell Limited, the makers of the instruments, the equipment was evolved to meet the requirements of high volume level, good reproduction and elimination of feed back, and so on.



Loudaphone equipment mounted in driving compartment.

In its final form the equipment consists of a diecast box with a hinged cover on the inside of which most of the components are fitted. The instrument is mounted at the left side of the driving window of each driver's cab as shown in the illustration. An extension bell is fitted in each guard's compartment operating in parallel with the buzzer.

Loudaphones are energised from the control supply but in the event of a line failure, the control voltage is automatically derived from the emergency battery and the equipment is designed to work at the lower discharge voltage of the battery.

Operation.

The equipment is operated in a similar manner to that of a simple self-contained telephone system. Attention is called by pressing the call button which energises the buzzer in the remote instrument and the bell in the guard's compartment, acknowledgment being made in the same way. Both speak buttons are then pressed and conversation is established.

The communicating door between motorman's cab and guard's compartment enables the guard, on receiving a call bell signal from the motorman, to use the speaking instrument in the adjacent cab.

The equipment is being manufactured by Clifford & Snell Limited of Sutton, Surrey, to the specification drawn up by the Chief Mechanical & Electrical Engineer, Southern Region, Mr. W. J. A. Sykes, to meet the requirements of the Chief Operating Superintendent of the Region, Mr. S. A. Fitch.

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(FEBRUARY 1958)

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1957 **62** (01 & **669** .1

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WINTON (D.A.). — **Coated steel sheet for rolling stock construction.** (1 500 words & figs.)

1957 **624** .5 (73)
The Railway Gazette, October 18, p. 448.
Unusual bridge over marshalling yard. (300 words & fig.)

1957 **621** .131. 3 (42)
The Railway Gazette, October 18, p. 449.
British Railways express steam locomotive trials. (1 000 words & figs.)

1957 **621** .33 (42)
The Railway Gazette, October 25, p. 477; November 8, p. 536.
Southern Region change of frequency scheme.-1-2. (2 200 words & figs.)

1957 **621** .338 (42)
The Railway Gazette, October 25, p. 479.
London Transport prototype Tube train. (1 800 words, tables & figs.)

1957 **625** .232
The Railway Gazette, October 25, p. 484.
Eleven-compartment sleeping cars for Wagons-Lits Company. (300 words & figs.)

1957 **625** .28
The Railway Gazette, November 1, p. 501.
Use of motive power. (400 words.)

1957 **621** .431 .72
The Railway Gazette, November 1, p. 501.
Low-grade fuel for Diesels. (300 words.)

1957 **621** .431 .72 (42)
The Railway Gazette, November 1, p. 506.
First type « B » Diesel-electric locomotive. (200 words & fig.)

1957 **625** .143 .3 (42)
The Railway Gazette, November 1, p. 509.
DEARDEN (J.). — **Rail failures on British Railways.** (1 000 words & figs.)

1957 **625** .1 (42)
The Railway Gazette, November 8, p. 534.
Widening between Rainham and Newington, Southern Region. (300 words, 1 map & figs.)

1957 **625** .243 (43)
The Railway Gazette, November 8, p. 538.
Development of amphibious vehicles. (500 words & figs.)

Diesel Railway Traction. (London.)

1957 **621** .431 .72 (5)
Diesel Railway Traction, October, p. 393.
Shunting locomotives for Israel. (100 words & figs.)

1957 **625** .285 (436)
Diesel Railway Traction, November, p. 403.
Twin-car Austrian Diesel sets. (800 words & figs.)

1957 **625** .213
Diesel Railway Traction, November, p. 405.
Torsion bar suspension. (600 words & figs.)

1957 **385** .586 (42)
Diesel Railway Traction, November, p. 408.
Diesel training on British Railways. (900 words.)

1957 **621** .431 .72 (941)
Diesel Railway Traction, November, p. 409.
Shunter performance in Western Australia. (1 300 words & figs.)

1957 **621** .431 .72 (436)
Diesel Railway Traction, November, p. 413.
Powerful locomotive on mountain grades. (1 000 words & figs.)

Railway Locomotives and Cars. (New York.)

1957 **625** .26 (73)
Railway Locomotives and Cars, October, p. 21.
New shop solving N & W car problems. (800 words & figs.)

Railway Steel Topics. (Sheffield.)

1957 **625** .143 .3
Railway Steel Topics, No. 2, p. 6.
Roaring rails. (2 000 words.)

1957 **625** .212
Railway Steel Topics, No. 2, p. 19.
HUNDY (B.B.). — **Shelling of railway wheels.** (6 500 words & figs.)

1957 **621** .431 .72 (73)
Railway Steel Topics, No. 2, p. 36.
WATKIN (E.R.S.). — **Diesel locomotives in industry.** (2 100 words & 1 fig.)

In Spanish.

Revista de Obras Públicas. (Madrid.)

1957 **621** .31
Revista de Obras Públicas, noviembre, p. 580.
FERNANDEZ BELLO (M.). — Ensayos de **torres metalicas para lineas electricas de transporte.** (1 000 palabras & fig.)

1957 **621** .89
Revista de Obras Públicas, noviembre, p. 598.
MARTIN RUEDA (J.). — **Lubricantes minerales con aditivos.** (3 000 palabras & figs.)

1957 **625** .143 .5
Revista de Obras Públicas, noviembre, p. 612.
KLEIN (R.) & WEGNER (U.). — Principios constructivos modernos en la superestructura de ferrocarriles, aplicados en la fabricación de **escarpias de resorte J. Flex y T. Flex.** (1 500 palabras & fig.)

In Italian.

Giornale del Genio Civile. (Roma.)

1957 **624** .2
Giornale del Genio Civile, settembre, p. 665.
MORANDI (R.). — Sulle condizioni di sicurezza nel tempo per tiranti pretesi, disposti allo scopo di produrre **distorsioni volute alle estremità di una trave.** (4 000 parole & fig.)

1957 **721** .1
Giornale del Genio Civile, settembre, p. 698.
GERARDI (P.). Sul **calcolo dei reticoli di fondazione.** (2 000 parole, tabelle & fig.)

1957 **624** .2
Giornale del Genio Civile, ottobre, p. 783.
ROSSETTI (U.). — Contributo allo **studio di travi in cements armato in fase anelastica ed a rottura.** (7 000 parole & fig.)

Ingegneria Ferroviaria. (Roma.)

1957 **625** .42

Ingegneria Ferroviaria, ottobre, p. 795.

GUZZANTI (C.). — Della **coesistenza di servizi urbani e suburbani su una stessa linea ferroviaria metropolitana.** (15 000 parole & fig.)

1957 **624**

Ingegneria Ferroviaria, ottobre, p. 821.

DI BERARDINO (V.) & GIRARDELLI (L.). — Il **metodo di Hardy Cross** e la sua giustificazione mediante un nuovo procedimento di risoluzione dei sistemi di equazioni algebriche lineari. (4 000 parole & fig.)

1957 **385** .588

Ingegneria Ferroviaria, ottobre, p. 833.

SANTORO (F.). — **Politica sindacale** e **problemi economici** delle ferrovie. (3 000 parole.)

1957 **625** .18 (45)

Ingegneria Ferroviaria, ottobre, p. 837.

LOMBARDO (M.). — Gli approvvigionamenti nell' Azienda delle Ferrovie dello Stato. La **scelta dei materiali.** (1 500 parole & tavole.)

1957 **621** .138 .1 (45)

Ingegneria Ferroviaria, ottobre, p. 845.

ZATTONI (T.). — Il **deposito locomotive elettriche** di Palermo. (1 500 parole & fig.)

Rivista di Ingegneria. (Milano.)

1957 **621** .3

Rivista di Ingegneria, novembre, p. 1233.

BARONI (R.). — Principi di funzionamento dei **dispositivi a semiconduttori.** Conduttori electronici. (2 500 parole & fig.)

1957 **62** (01

Rivista di Ingegneria, novembre, p. 1241.

PERUCCI (G.). — Un **particolare sistema soggetto a diversi fenomeni di instabilità.** (3 000 parole & fig.)

1957 **621** .3

Rivista di Ingegneria, novembre, p. 1251.

MASSA (E.). — **L'assorbitore dinamico non lineare non smorzato con vincolo elastico di rigidezza costante a tratti** *(continuazione)*. (800 parole.)

Trasporti Pubblici. (Roma.)

1957 **621** .431 .72

Trasporti Pubblici, ottobre, p. 1277.

GENTILI (A.). — Le **trasmissioni meccaniche ed idrauliche** nella trazione ferroviaria con motori Diesel. (11 000 parole & fig.)

1957 **624** (45)

Trasporti Pubblici, ottobre, p. 1355.

CHIOTA (M.). — Ferrovia Crotone-Petilia-Policastro. **Difesa di sponda sul fiume Tacina.** (1 000 parole, tavole & fig.)

In Netherlands.

De Ingenieur. (Den Haag.)

1957 **625** .13

De Ingenieur, nr 44, 1 november, p. B. 109.

EGGINK (A.). — **Gezonken tunnels.** (3 000 woorden & fig.)

1957 **621** .31

De Ingenieur, nr 44, 1 november, p. E. 131.

FONTEIN (W.). — De **grondslagen van de gelijkstroommachines** ten behoeve van regelsystemen. (2 000 woorden & fig.)

1957 **621** .31

De Ingenieur, nr 48, 29 november, p. E. 155; nr 52, 27 december, p. E. 185.

Stootspanningen. I. *Ontstaan en voortplanting van stootspanningen*, door Ir. P.G. PROVOOST. II. *Beveiliging tegen stootspanningen*, door Ir. R.F. GOOSSENS. (4 000 woorden & fig.)

1957 **621** .31

De Ingenieur, nr 48, 29 november, p. E. 163.

WALLIS (A.S.). — **Applications of the Amplidyne.** (2 000 woorden & fig.)

1957 **625** .2

De Ingenieur, nr 51, 20 december, p. W. 169.

DE PATER (A.D.). — Onderzoekingen op het gebied van de **rustige gang van voertuigen.** (3 000 woorden & fig.)

Spoor- en Tramwegen. (Den Haag.)

1957 **621** .431 .72 (4)

Spoor- en Tramwegen, nr 23, 7 november, p. 357.

Standardatie en de ontwikkeling der dieseltractie in Europa. (1 500 woorden.)

1957 **656** .225

Spoor- en Tramwegen, nr 24, 21 november, p. 373.

FLIPSE (J.L.). — Het **Bureau International des Containers.** (1 000 woorden & fig.)

1957 **624** (492)

Spoor- en Tramwegen, nr 24, 21 november, p. 379.

Rhenen had een spoorbrug, krijgt nu een **brug voor wegverkeer.** (700 woorden & fig.)

1957 **656** .225

Spoor- en Tramwegen, nr 25, 5 december, p. 392.

Het **gebruik van containers** in het bijzonder bij vervoer per spoor. (1 500 woorden.)

1957 **656**

Spoor- en Tramwegen, nr 25, 5 december, p. 394; nr 26, 19 december, p. 406.

LANDSKROON (F.P.A.). — De **coördinatie van het vervoer.** I. (4 000 woorden.)

1957 **347** .763 .4 (494)
Spoor- en Tramwegen, nr 25, 5 december, p. 396.
HOOFTMAN (J.C.). — Verkeerspolitieke aspecten van de **nieuwe Zwitserse spoorwegwet.** (2 000 woorden.)

In Portuguese.

Boletim da C.P. (Lisboa.)

1957 **656** .257
Boletim da C.P., dezembro, p. 2.
SIMOES DO ROSARIO (A.). — **O sistema de encravamento de agulhas e sinais NX.** (1 000 palavras & fig.)

In Swedish. (= 439 .71.)

Järnvägs-Teknik — Statsbaneningenjören. (Stockholm.)

1957 **625** .22 (4) = 439 .71
Järnvägs-Teknik Statsbaneingenjören, No. 4, p. 81 and No. 5, p. 126.
EKLUND (P.). — **Free section gauge.** (6 000 words & fig.)

1957 **625** .28 = 439.71
Järnvägs-Teknik Statsbaneingenjören, No. 5, p. 132.
BAGER (H.). — Contribution **relating to a study comparing various traction methods** (steam, diesel and electric). (2 000 words & tables.)

In Czech. (= 91.886.)

Železničnı́ Technika. (Praha.)

1957 **656** .212 .5 = 91 .886
Železničnı́ Technika, No. 10, p. 245.
SVOBODA (H.). — **Braking of wagons in marshalling yards.** (3 000 words & fig.)

1957 **621** .33 = 91 .886
Železničnı́ Technika, No. 11, p. 277.
VORONIN (A.V.). — **Experience in electric traction with single phase, industrial frequency current.** (2 000 words & figs.)

1957 **621** .33 (47) = 91 .886
Železničnı́ Technika, No. 12, p. 313.
JANSA (F.). — **Electrification of the Soviet Railways.** (3 000 words & figs.)

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